NARRAGUAGUS RIVER FLOOD CONTROL

CHERRYFIELD

DAM & RESERVOIR
LOCAL PROTECTION

NARRAGUAGUS RIVER, CHERRYFIELD, MAINE

DETAILED PROJECT REPORT

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

OCTOBER 1960

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.
NEDGW

24 October 1960

SUBJECT: Cherryfield Dam and Reservoir, Local Protection Project, Narraguagus River, Cherryfield, Maine - Detailed Project Report

TO: Chief of Engineers
Department of the Army
Washington 25, D.C.
ATTENTION: ENGCW-P

1. In accordance with ER 1165-2-102 there are submitted copies of the Detailed Project Report, Cherryfield Dam & Reservoir, Cherryfield, Maine.

2. This report incorporates the comments of OCE on the preliminary report.

3. It is recommended that the project, as submitted in this report, be authorized for construction. It is further recommended that $9,000 be allotted for design. Construction funds will be requested upon completion of plans and specifications and the receipt of bids for construction.

FOR THE DIVISION ENGINEER:

John Wm. Leslie

JOHN WM. LESLIE
Chief, Engineering Division

Incl
Detailed Project Report
Cherryfield Dam & Reservoir (10 cys)

CHERRYFIELD DAM

LOCAL PROTECTION PROJECT

NARRAGUAGUS RIVER
CHERRYFIELD, MAINE

DETAILED PROJECT REPORT

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NARRAGUAGUS RIVER

NARRAGUAGUS RIVER BASIN

CHERRYFIELD, MAINE

DETAILED PROJECT REPORT

April 1960

A. PERTINENT DATA

1. Purpose	Ice-jam flood control of Narraguagus River
2. Location	Dam located about one mile above center of Cherryfield, Washington County, Maine
3. Type of Improvement	Dam and Reservoir for retention of ice
4. Hydrology	
Maximum flow of record	7,250 c.f.s.
Project design flood	15,000 c.f.s.
Drainage area	234 sq. miles
5. Spillway	
Type	Rock-filled timber crib weir
Length	140 feet
Height	7 feet above river bed
Crest elevation	57.0 m.s.l.
Maximum head	11.08 feet
Capacity, reservoir at elevation 68.8	15,000 c.f.s.
Sluiceways	Two, each 3.5 feet wide at elevation 53.2

6. Dam

Type	Rock-filled timber crib abutments and earth and rock-fill embankment
Length	485 feet including spillway
Maximum height above stream-bed	22.5 feet
Elevation of top	72.5 m.s.l.
Slopes of Embankment:	
Upstream	1 on 2
Downstream	1 on 2, 1 on 2½
Width of top	14 feet
Timber crib Abutments:	
West	
Height from base	24.5 feet
Top elevation	72.5 m.s.l.
Width	16 feet
Length	66 feet
East	
Height from base	24.5 feet
Top elevation	72.5 m.s.l.
Width	18 feet
Length	51 feet
Wingwalls:	
Upstream	8 feet wide X 14 feet long
Downstream	8 feet wide X 23 feet long

7. Fishway

Type	Denil
Entrance elevation	49.0 m.s.l.
Exit elevation	55.0 m.s.l.
Width	3.5 feet
Number of baffles	17
Slope of floor	1 on 6±

8. Principal Quantities

Timber	223 M.F.B.M.
Excavation	7,000 c.y.
Earth-fill	2,000 c.y.
Rock-fill	4,350 c.y.
Crushed stone-fill	750 c.y.
Gravel-fill	550 c.y.

9. Cost Estimates

First Costs:

Federal	$175,000
Non-Federal	3,500
Total	$178,500

Annual Costs:

Federal	5,583
Non-Federal	1,160
Total	6,743

10. Benefits

Average Annual Benefits	13,000
Benefit-Cost Ratio	1.9 :1.00

B. PROJECT AUTHORITY

This Detailed Project Report is submitted pursuant to authority contained in Section 205 of the Flood Control Act of 1948 as amended by Section 212 of the Flood Control Act of 1950 and Public Law 685, 84th Congress, 2nd Session. Further authority is contained in 1st indorsement dated 14 May 1959 from the Chief of Engineers in reply to letter dated 5 May 1959 from the Division Engineer, New England Division subject: "Flood Control Project, Narraguagus River at Cherryfield, Maine".

C. SCOPE OF DETAILED PROJECT REPORT

1. Scope. This design memorandum reviews the ice-jam flood control problem on the Narraguagus River in Cherryfield, Maine. It submits a definite project for ice-jam flood protection for Cherryfield by construction of a dam and reservoir for retention of ice.

2. Topographic Surveys. Plane table surveys of the proposed dam site, on a scale of 1" = 20' and a contour interval of 2 ft. were available.

3. Subsurface Explorations. Geological reconnaissance has been made in the project area and adjacent areas in connection with site studies and borrow investigations. Subsurface explorations are limited to the project area and consist of two (2) foundation drive sample and core borings completed in 1948.

4. Flood Damage Surveys. A field review was made in 1949 of survey data obtained by local officials of all flood losses experienced in the Narraguagus River Basin in the period beginning May 1923. A door-to-door survey was made in the Cherryfield area immediately after the ice-jam flood of April 1959, consisting of interviews and inspections with owners, tenants or officials of the various residential, commercial, industrial and public properties affected by flooding. The results of flood damage surveys are summarized in Section L, Flood Losses, of this design memorandum.

5. Real Estate Studies. Field reconnaissance and conferences with local officials were used as the basis for estimates of real estate costs.

6. Conference with Local Interests. Close liaison has been maintained with Town and State Officials, local property owners, and other interested parties. In addition to the Public Hearing held in Cherryfield, Me., on May 6, 1947 a

Public Hearing was held in November 1959 to determine the need for and to receive testimony on local desires for protection against flooding caused by ice-jams. Sentiment was favorable to the provision of protection; however, it was brought out that full consideration should be given to the fishery problem.

D. PRIOR REPORTS

7. Preliminary Report. A preliminary examination for ice-jam flood control on the Narraguagus River at Cherryfield was submitted to the Chief of Engineers on 22 September 1947.

8. Survey Report. A survey report for ice-jam flood control at Cherryfield, Me. was submitted to the Chief of Engineers on 1 December 1949. The report recommended that no improvement of the Narraguagus River be undertaken at that time. An unfavorable report was transmitted to Congress by the Secretary of the Army on 27 July 1951.

9. NENYIAC Report. The report entitled "The Resources of the New England-New York Region" was prepared by the New England-New York Inter-Agency Committee under the directive contained in Presidential Letter of October 9, 1950. Part Two, Chapter X of the NENYIAC Report, entitled, "Maine Coastal Area" includes data on the Narraguagus River.

10. Reconnaissance Report. In response to requests from Congressional and local interests and in compliance with ER 1165-2-102, a reconnaissance and damage survey of April, 1959 ice-jam flooding and review of previous flood control reports was made of the Narraguagus River flood control problem at Cherryfield, Me. The report stated that construction of a low rock-filled timber crib dam would relieve the difficulties of ice-jam floods at Cherryfield and it was apparent that the project might be economically feasible and would come under the scope of Public Law No. 685. It recommended that the New England Division be authorized to prepare a detailed project report. By first endorsement dated 14 May 1959, the Chief of Engineers authorized preparation of a Detailed Project Report.

E. DESCRIPTION OF AREA

11. Geography. The Narraguagus River Basin is located in Hancock and Washington Counties in northeastern Maine, with the center about 35 miles east of Bangor. The basin, which comprises approximately 240 square miles, has a length of 35 miles and a width varying from 2 to 16 miles, averaging nearly seven miles. There are about 5 square miles of lakes and ponds and 16 square miles of swamp and marsh land within the watershed.

12. <u>Topography.</u> The Narraguagus Valley is located in the seaboard lowland in a region of low to moderate relief, characterized by low broad hills, wide valleys and numerous swamps. The lower part of the basin includes small areas of cultivated land and extensive blueberry fields. The upper part is heavily wooded. The topography is resultant of long continued pre-glacial erosion modified by glacial and post-glacial erosion and deposition, and is to a large degree bedrock controlled. The region is underlain by crystalline rocks consisting mainly of granite with associated bodies of diorite, and older, banded micaceous gneisses and schists. These rocks outcrop rather extensively at the higher elevations, and at many locations in the river beds where they form falls or rapids. Elsewhere in the region, the bedrock is overlain by variable thick deposits of glacial till and outwash. The present drainage is the result of an irregular overflow through the glacial overburder and very little systematic drainage has been developed. Consequently, there is considerable natural storage and storm run-off is low.

13. <u>Geology.</u> The Narraguagus River enters the project area from the northwest through a relatively broad, flat bottomed valley, meanders through the site, then resumes its southeasterly course to the ocean. At the side the river valley is restricted by a high ridge which projects into the valley from the northeast. In this area, the river, the bed of which is paved with boulders, is flowing upon a thick section of overburden. A short distance downstream, however, in the vicinity of the Main Central railroad bridge, bedrock forms the bed and west bank of the river.

14. <u>Main River.</u> The Narraguagus River rised in Eagle Lake, Township 34, Hancock County, Maine, flows in a general south - south-westerly direction for a distance of about 49 miles, emptying into Narraguagus Bay and the Atlantic Ocean about 20 miles northeast of Bar Harbor, Maine. The total fall of the river is 406 feet. Its slope between Eagle Lake and Cherryfield varies from about 4 to 14 feet per mile except for two localities. At DeBlois, about 15 miles above Cherryfield, a fall of 40 to 50 feet occurs within about one-half mile. Just above the village of Cherryfield the river drops nearly 50 feet within a distance of about 0.8 miles. Five rock-filled timber dams that were located within this section of the river have been destroyed and are no longer in existence. The river is tidal below Cherryfield with ranges of three to seven feet at Cherryfield and 10 to 14 feet at the mouth. A profile of the river through the village of Cherryfield is shown on Plate No. 3 submitted with this report.

15. Tributaries. The only important tributary of the Narraguagus River is the West Branch which enters from the northwest about 8.4 miles above the mouth of the Narraguagus. This tributary, which drains 80 square miles in the southwestern part of the basin, falls about 350 feet in its 22.5 mile length. Numerous small streams and brooks with relatively steep slopes also feed into the Narraguagus River and the West Branch.

16. Maps. The Narraguagus River and its drainage basin are shown on standard quadrangle sheets of the U. S. Geological Survey, scales of 1:62,500 and 1:25,000. They are shown also on standard quadrangle sheets of the Army Map Service, scales of 1:50,000 and 1:25,000 and on Plate No. 1 accompanying this report. The lower nine miles of the river are shown on U. S. Coast and Geoditic Survey Chart No. 305 which gives the depths in the river up to and 500 yards upstream of Millbridge.

F. CLIMATOLOGY

17. General. The Narraguagus River Basin has a variable climate characterized by frequent but usually short periods of precipitation. The basin lies in the path of the "prevailing westerlies" and the cyclonic disturbances that cross the country from the west or southwest. It is also exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic seaboard, especially in late summer and the autumn months. The southern portion of the basin, due to its proximity to the Atlantic coast, escapes the severity of cold and depth of snowfall experienced in the higher elevations.

18. Temperature. Average monthly temperatures in the Narraguagus River Basin vary widely through the year with a mean annual temperature of about 44° F. Based on records at Bar Harbor, Maine which would be representative of the coastal area, and Woodland, Maine which would be typical of the upper basin, extremes of temperature have varied from -41° F to 107° F. Freezing temperatures can be expected from October through April of each year. Table 1 is a summary of mean monthly and extreme temperatures as recorded at Bar Harbor, Maine for 61 years and Woodland, Maine for 32 years.

TABLE I

MONTHLY TEMPERATURES
(Degrees Farenheit)

	Bar Harbor, Maine			Woodland, Maine		
Elevation, Ft.,m.s.l.	30			140		
Years of Record	61			32		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	23.6	63	- 20	17.3	57	-38
February	24.3	57	- 21	18.5	54	-38
March	32.5	78	- 9	28.5	77	-21
April	42.5	83	11	40.7	84	6
May	53.0	92	22	52.1	94	21
June	61.2	97	32	61.4	98	29
July	67.1	96	36	68.0	107	36
August	66.2	98	36	66.5	102	35
September	58.9	96	27	57.6	95	23
October	49.6	89	20	47.0	84	14
November	39.4	70	- 3	35.4	74	- 4
December	27.0	66	- 21	21.7	60	-41
Annual	45.4	98	- 21	42.9	107	-41

19. Precipitation. The mean annual precipitation over the Narraguagus River watershed has been estimated to vary from about 49 inches at the coast to about 38 inches in the headwater. The mean, maximum and minimum, monthly recorded precipitation for Machias and Orono, Maine, which are representative of the coastal and upper basis respectively, are summarized in Table 2.

TABLE 2

MONTHLY PRECIPITATION RECORD
(In Inches)

	Machias, Maine			Orono, Maine		
Elevation, Ft.,m.s.l.	40			115		
Years of Record	77			88		
Month	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	4.64	10.70	1.10	3.15	8.54	0.67
February	4.21	7.94	1.43	2.94	8.39	0.83
March	4.39	8.68	1.84	2.89	8.89	0.34
April	4.03	7.81	0.51	3.10	6.98	0.66
May	3.41	9.00	0.43	3.12	10.52	0.48
June	3.68	9.14	0.56	2.96	8.66	0.62
July	3.22	7.11	0.33	2.81	7.63	0.27
August	3.21	7.13	0.51	2.60	7.36	T
September	4.51	9.09	0.85	3.41	9.09	0.81
October	3.98	13.90	0.48	3.51	9.57	0.58
November	5.19	11.85	0.65	3.82	8.67	0.36
December	4.48	8.98	1.33	3.13	7.94	1.01
Annual	48.95	65.52	23.06	37.44	58.74	25.99

20. Snowfall. The mean annual snowfall over the watershed has been estimated to be about 70 inches. The snow cover reaches a maximum depth in early March with the water content often over five inches. The mean monthly snowfall for the periods of record at Bar Harbor, Orono and Woodland are summarized in Table 3.

TABLE 3

MEAN MONTHLY SNOWFALL
(Average Depth in Inches)

	Bar Harbor, Maine	Orono, Maine	Woodland, Maine
Elevation,Ft.,m.s.l.	30	115	140
Years of Record	47	15	21
Month			
January	17.5	15.3	17.9
February	19.7	16.5	19.4
March	11.3	10.8	13.5
April	4.8	2.6	5.4
May	0.1	0.2	0.1
June	0	0	0
July	0	0	0
August	0	0	0
September	0	0	0
October	0.1	0.1	0.4
November	3.9	5.2	6.1
December	10.3	11.7	14.0
Annual	67.8	62.4	76.8

21. Storms. The rapidly moving cyclonic storms or "lows" that move into New England from the west or southwest produce frequent periods of unsettled, but not extremely severe weather. The region is exposed to occasional coastal storms, some of tropical origin, that travel up the Atlantic coast and move over or within striking distance of the New England States.

The following data is a summary of the estimated precipitation associated with the higher discharges or ice-jam floods of record in the Narraguagus River:

Year	Month	Dates	Precipitation in Inches
1923 (a)	April	28 - 20	4.2
1936 (b)	March	12-13 18-21	4.7
1942 (b)	March	3 - 7 - 9	4.8
1945 (b)	January	1 - 3	1.5
1949 (b)	January	Dec 30 - Jan 1 - 2	2.6
1950	November	26 - 30	5.0
1953 (b)	March	25 - 31	4.4
1954 (b)	April	15 - 18	4.2
1954	September	11 - 15	5.8
1959 (b)	April	2 - 5	1.9

(a) Flood without ice
(b) Ice-jam Flood

G. RUNOFF

22. Discharge Records. In February 1948, the U. S. Geological Survey established a recording stream gage on the Narraguagus River just above the Village of Cherryfield. The gage measures runoff from a drainage area of 232 square miles. There are no other records of streamflow on the river. In the adjoining basin to the northwest, a recording station with a drainage area of 148 square miles has been in operation on the West Branch of Union River at Amherst, Maine since July 1929. The nearest stream gaging station to the east is located on the Machias River at Whitneyville, Maine. This station, with a drainage area of 457 square miles, has been in operation as a recording station since September 1929. It was operated as a chain gage station from October 1903 to September 1921.

The records of three stations are all affected by ice each year; therefore, many of the spring flows are estimated. A plot of the stream flow records of the Narraguagus River at Cherryfield is shown on Plate No. 8. The stream flow records for these three gaging stations are summarized in Table 4.

TABLE 4

STREAMFLOW RECORDS

Location of Gaging Station	Drainage Area	Period of Record	Mean	Discharge (C.F.S.) Maximum	Minimum
Narraguagus River at Cherryfield, Me.	232	1948-1959	479	7,250	28
West Branch, Union River at Amherst, Me.	148	1929-1959	258	4,140	3.6
Machias River at Whitneyville, Me.	457	1903-1921 1929-1959	936	11,800	3.5

23. Runoff. The annual runoff for the 10 complete years of record through September 1959 for the gage at Cherryfield varied from 295 c.f.s in 1957 to 621 c.f.s. in 1953 with a mean 406 c.f.s. Table 5 is a summary of the maximum, minimum and mean monthly runoff in c.f.s. for the period of record on the Narraguagus River at Cherryfield, Maine.

TABLE 5

MONTHLY RUNOFF IN C.F.S.

NARRAGUAGUS RIVER AT CHERRYFIELD, MAINE
(Drainage Area = 232 square miles)

February 1948 - September 1959

Month	Mean	Maximum	Minimum
January	676	1120	386
February	481	882	192
March	700	1340	249
April	1170	1560	711
May	619	1260	336
June	305	657	135
July	137	338	72
August	115	249	44
September	179	946	35
October	201	612	34
November	559	1120	162
December	642	1240	88
Annual	406	621	295

H. FLOODS OF RECORD

24. Flood Causes. The flood damage at Cherryfield is caused primarily by ice conditions in the spring freshet season. The channel capacity through the Town has been estimated to be between 9,000 and 12,000 c.f.s. without ice conditions, but serious flooding with ice jams have occurred with flows estimated to be between 4,000 and 6,500 c.f.s. It appears that the major factor that determines whether or not a serious ice jam will develop is the condition of ice in the frozen flats or tidewater section of the river below the village. If the ice in this lower portion of the river is gone at the time of the spring "breakup" upstream, the ice and water will flow by the Town without causing any serious flooding. However, if the tide water ice has not gone out, then the floating river ice from upstream will jam against it and create a temporary dam,flooding the Village of Cherryfield.

Prior to 1942, a series of dams were located just upstream of Cherryfield. It is the contention of the local people that thick pond ice developed back of these dams held the ice until it "rotted" and went out as streamflow, thereby preventing serious jams and flooding. In the absence of the ponds created by these dams, there is a potential every year that the upstream river ice can breakup and float downstream while the tidewater section is still frozen.

25. Floods of Records. Cherryfield has been subjected to four serious damaging floods in the last 36 years. They occurred in May 1923, March 1936, March 1942 and April 1959. The floods of March 1936 and March 1942 were seriously aggravated by the failure of Stillwater dam located in the upper end of the Village. This was true to a lesser degree in the flood of May 1923 when the dam was less seriously damaged. Based on records of adjacent streams, the flood of May 1923 due to high flows rather than to ice jams could have had the maximum discharge of record although the river stage at Route 1 highway bridge in the center of Cherryfield was about 6.5 feet below the maximum stage of 17.7 feet M.S.L. experienced in March 1942. The flood of April 1959 created an estimated stage of 15.5 at the highway bridge. This was due to high flows and ice jams as the upstream dams no longer existed. Table 6 is a summary of stages and discharges with and without ice as have been estimated for floods during the past 36 years.

TABLE 6

SUMMARY - STAGES & DISCHARGES

NARRAGUAGUS RIVER AT CHERRYFIELD, MAINE
(Route #1 Highway Bridge)

Date	Estimated Discharge (cfs)	Experienced Stage	Estimated Stage Without Ice *	Remarks
May 1923	10,000 (Est.)	11.2	11.2	Stillwater dam, damaged
March 1936	5,000	14.5	7.2	Stillwater dam, damaged
March 1942	4,600	17.7	6.8	Stillwater dam, washed out
Jan. 1945	-	10 to 11	-	Used Dynamite
Jan. 1949	3,600	10.5	5.9	
Jan. 1951	3,140	11.0	5.5	
Jan. 1953	5,800	11.0	7.8	
Jan. 1954	6,900	11.5	8.6	
Apr. 1959	6,550	15.5	8.3	

* From Steady Flow Rating Curve.

I. FLOOD FREQUENCY

26. General The frequency of damaging ice-jam floods at Cherryfield cannot be determined with any high degree of accuracy because of the short period of record and the fact that the three of the more serious floods have been coincident with dam failures. Ice jams have been occurring with greater frequency under present conditions of no dams than in the past when the upstream dams existed.

27. Frequency of Floods Without Ice. It was considered that the most rational approach to determining the frequency of ice-jam floods would require the derivation of a discharge frequency curve which could than be converted to stage-frequency and adjusted to account for the effect of ice. A

discharge frequency curve was developed in accordance with procedures described in Civil Works Engineer Bulletins 51-1 and 51-14, using logarithmic values of annual peak flows. A skew coefficient of 0.3 and the historical adjustment were derived from an analysis of the records on the West Branch of the Union River and the Machias River and correlated to the Narraguagus River Basin. The peak discharge-frequency curve is shown on Plate No. 11. It indicates that under non-ice conditions, the Village of Cherryfield would experience bank-full capacity or greater about once in a hundred years.

28. Frequency of Floods with Ice. Many indefinite and unpredictable factors are introduced in considering the frequency of floods with ice. Some of the factors that complicate the problem and make the usual analytical solution impossible may be enumerated as follows:

a. The natural run-off in the river may be a minor flow, moderate, or even a flood run-off concurrent with adverse ice conditions.

b. The extent of the winter ice and the rapidity with which it breaks up. Conditions are likely to be worse in a winter or early spring break-up when the ice is hard.

c. The number of jams and volume of ice accumulated upstream, the manner and rapidity that upstream jams break up and move downstream. Upstream jams may cause the flow to back up and then break with a surge causing a new jam downstream. Such conditions cause river flow to be very irregular with alternate periods of low and high discharge.

d. The extent of ice in the tidal reach of the Narraguagus River and its condition at the time the river ice breaks up. Ice, reported seven to eight feet thick, in the estuary may raise stages at Cherryfield ever without the break-up of river ice.

e. The condition of the tide coincident with the jam at Cherryfield.

f. The location where the jam forms and the height that the ice may build up before breaking. Records of ice jams on other New England rivers of similar size indicate that ice jams can raise the water stage from two to eight feet.

29. Frequency Curve, Ice-Jam Floods. The adopted curve showing the frequency of ice-jam floods required for the economic analysis is shown on Plate No. 11. This curve was derived as follows:

a. The experienced stages, shown in Table 6, were assigned similar frequencies to those determined for the discharge coincident with the flood. These values, plotted on Plate No. 11 with arithmetic probability scales, show quite a scatter of points. The adoption of these frequencies would assume that an ice jam would always be coincident with these high flows. An inspection of the record at the gaging station, as plotted on Plate No. 8, will show that the assumption is not acceptable since the Narraguagus River often experiences high flows during the latter part of the year when ice is not a factor. The record also shows that ice jams have been experienced about one-third the number of times that high flows have been recorded. On this basis an average line drawn through the scattered points was shifted to reduce the probability to about one-third the previous assigned values. A curve was developed from plotted data using the formula of $F = \frac{2n}{2m-1}$ with n = 24 years. The resultint curve was applied to the economic analysis and it was found that the change in the computed annual loss was insignificant. Therefore, it was concluded that the adopted curve for the frequency of ice-jams as shown on Plate No. 11 was acceptable for economic analysis.

J. STANDARD PROJECT FLOOD

30. General. Consideration has been given to two possible conditions of damaging floods at Cherryfield:

a. A flood produced by rain, melting snow or combination of both where the flood stage is a function of discharge.

b. A flood produced by ice, where the flood stage is primarily a function of the magnitude and damming effect of the ice jam in addition to the discharge.

31. Flood Without Ice. An attempt was made to develop a standard project flood using procedures described in Civil Works Bulletin 52-8. Approximate unit hydrographs had to be used due to the meager hydrograph data. The gage record was lost during the record non-damaging flow of November 1950, while the remaining hydrographs of large flows all include some snow melt. The resultant peak discharges for the standard project floods were developed as follows:

Type	SPF Rainfall (inches)	Rainfall Excess (inches)	Peak Discharge (c.f.s.)
All Season	12.3	8.2	24,600
May	9.2	6.9	19,700
April	8.2	5.8	15,600

32. Flood with Ice. The many indefinite and unpredictable factors that were involved in the derivation of flood frequencies as described in paragraph 9.3 are also involved in a standard project flood with ice. After considering the many problematical factoris, it is concluded that it is impracticable to develop a standard project flood involving ice jams. However, it is considered that a standard project flood with ice may be assumed as approaching the flood of 1942.

K. PROJECT DESIGN FLOOD

33. General. For the purposes of ice-jam flood design, a project design flood was needed to determine the spillway requirements of the proposed dam and also the required wall or levee grades for an alternate plan of protection. Since flood control for high discharges is not a basic function of this project, it was decided that the extreme design for a spillway design flood or the most critical standard project flood was unwarranted.

34. Adopted Design Criteria. The proposed dam is designed for a maximum discharge of 15,000 c.f.s. with a freeboard of 3.7 feet. This will provide a capacity of more than twice the recent record flood of 7,250 c.f.s experienced in November 1950 without any dam failure. The spillway will also have 50 percent more capacity in a recurrence of the flood of May 1923, assuming that the discharge of 10,000 c.f.s could occur without ice or an upstream dam failure. For the consideration of alternate plans of dikes and walls at Cherryfield, a design grade equal to two feet above the 1942 flood plus three feet of freeboard was adopted. This would provide a grade about seven feet higher than the experienced April 1959 elevation.

L. FLOOD LOSSES

35. General. The Narraguagus River Valley has suffered serious losses from ice-jam flooding during the past several decades. Within this valley by far the hardest hit location has been the central village area of Cherryfield, which experienced substantial damage from ice-jam floods in 1936, 1942, 1954, and 1959. Ice-jam conditions have threatened the village almost annually in recent years, with record losses occurring in April 1959.

The flood of March 1936 caused an estimated loss of $20,000 in Cherryfield. One building was washed out and three low dams in the upper section of the village failed, including the Stillwater Dam. Major urban losses in this flood, as in more recent floods, occurred along the left bank in the central business district and in low-lying houses near the mouths of several small brooks which enter the Narraguagus within the central village area.

The March 1942 flood, which produced record flood stages at Cherryfield, inflicted damages estimated at $132,000. Failure of the Stillwater Dam created a surge of water and ice which damaged 43 buildings and claimed one life in this community. Seven homes, 20 commercial establishments and 3 public buildings experienced up to five feet of water at the first-floor level. Two small dams and a footbridge were destroyed in the upper section of the village and one building was razed as a result of the flood. Since the 1942 destruction of all dams immediately upstream of Cherryfield, minor flood damages have been reported approximately every second year.

The ice-jam flood of 1954, second largest of the recent floods, was reported to have caused a loss of nearly $20,000. Loss of facilities necessitated the evacuation of four homes during this flood. One flood-prone store was razed following the flood.

The destructive flood of April 1959, created by an ice-jam in the vicinity of the Route 1 bridge, resulted in a total loss of about $151,000 in the main village. Approximately four feet of water spilled over both banks of the river, causing huge ice chunks and an uprooted frame building to move against structures in the left bank business district. Eighteen houses, 20 commercial firms, 3 public buildings, 17 water supply wells and a cannery office suffered damages from moving ice cakes and inundations. Twenty of these buildings, primarily on the left bank near the Route 1 bridge, experienced water at the first-flood level.

Under present conditions, the surges from dam failures which contributed to high flood stages in 1936 and 1942 no longer threaten the area. A recurrence of the stages experienced during the 1959 flood would cause an estimated loss of $143,000. By comparison with the 1959 loss, the fair market value of all property in the flood area is estimated at nearly $500,000, as based on data from the Maine State Tax Assessor's office.

36. Annual Losses. Average annual losses have been derived by correlation of stage-damage, stage-frequency and discharge-frequency data to develop a damage-frequency relationship for ice-jam floods having a frequency of more than once in one hundred years. Available hydrologic data would not support development of the stage-frequency curve beyond a 100-year statistical period. Annual losses for the Cherryfield area are estimated to be about $13,000.

M. EXISTING CORPS OF ENGINEERS FLOOD CONTROL PROJECTS

There are no existing Corps of Engineers flood control projects in the Narraguagus River Basin or in the State of Maine.

N. IMPROVEMENTS BY FEDERAL AND NON-FEDERAL AGENCIES

37. Federal Improvements. An existing navigation project adopted in 1886 and completed in 1907 provides for a channel 200 feet wide and 11 feet deep to Long Wharf, Millbridge and 9 feet thence to to the anchorage known as "Deep Hole, Millbridge". A study is presently underway to determine if the project should be modified.

38. State and Local Improvements. There are no flood-control projects on the Narraguagus River. Five small rock-filled timber dams, construction by private interests, were once located on the river at cherryfield, but none are in existence at the present time. Four were used for power purposes in connection with the once flourishing lumber industry of the town. One was used for generating power for local use. Three were washed out or destroyed by ice and high water in March 1942; one was destroyed by fire in 1937, and one was abandoned over 40 years ago. The total power development at these five sites in 1911 was about 500 horsepower according to a report of the State Water Storage

Commission. The locations of these old dams are indicated on Plate 4 accompanying this report.

In May 1951 the Maine Sea-Run Salmon Commission destroyed by dynamite the Beddington Dam to remove the last barrier to an extra 25 miles of spawning grounds on the Narraguagus River. The Beddington Dam is about 20 miles upstream from Cherryfield.

O. IMPROVEMENTS DESIRED

39. Public Hearing - 1947. A well-attended public hearing was held in Cherryfield on May 6, 1947. The desire of local interests, as presented by the Board of Selectmen of Cherryfield, was for the construction of a flood-control dam on the Narraguagus River to eliminate the danger of future floods. It was stated that construction of a low dam at the Stillwater site, the uppermost of the five former dams at Cherryfield, would effectively control ice-jam floods and prevent damage in the Town. No one voice any objection to the improvement.

The proponents reported that destruction of the rock-filled timber crib dams at Cherryfield, especially Stillwater Dam, has resulted in an urgent need for protection against ice-jam floods. The dam at Stillwater created a shallow reservoir of about 310 acres. This reservoir prevented the formation of serious ice jams in the Spring by retaining the ice until it melted. Local residents maintained that with the dams gone they were now faced with the threat of an ice-jam flood each Spring. They estimated that serious jams may be expected to occur once in every four to eight years under conditions prevailing at the time.

The Townspeople of Cherryfield claimed that some form of flood protection was necessary if the present economic welfare of their community was to be maintained. They based their justification for improvement mainly upon the damages experienced in the flood of March 9, 1942. They fixed the loss sustained by them in this flood at over $100,000. This estimate of their loss was supported by the returns received from an extensive flood-loss survey conducted by Town Officials. Four other floods were reported to have occurred since 1923. Explosives were used with only partial success to break up ice jams in 1942, 1944 and 1945.

40. Public Hearing, 1959. A well attended public hearing was held on 4 November 1959 in Cherryfield, Maine to determine the best plan to provide protection against flooding caused by ice jams. The most feasible plan was presented, the construction of a low rock-filled log crib dam at the Stillwater site. The proposed dam would be constructed to prevent passage of ice down the river during the dangerous Spring freshet season. Incorporated in the dam is a Denil type fishway, for passage of Atlantic Salmon, approved by the Maine Department of Island Fisheries and Game and the U. S. Fish and Wildlife Service.

All who attended favored the provision of flood protection. However, it was also stated that "full consideration should be given to the fishery problem."

The fishery problem ranged from the need for design of the most efficient appurtenant structures on the proposed dam for passage of the migratory fish to the elimination of construction of a dam and the selection of an alternate protection plan. The alternate protection plans studies are discussed in Section P of this report.

P. FLOOD PROBLEM, RELATED PROBLEMS AND SOLUTIONS CONSIDERED

41. General. The major flood damages at Cherryfield are caused by ice conditions in the Spring freshet season as discussed in Sections H and O preceding. Each Spring, if the tide water ice has not gone down the river, the floating river ice from upstream forms a jam on the frozen flats a short distance downstream from the Route 1 highway bridge in Cherryfield. The river is backed up by the jam which soon intensifies and water and ice overflows the banks of the stream flooding the center of the Town. The capacity of the river channel at Cherryfield is adequate for usual flood flows without ice as evidenced by the flood experience of May 1923 which caused only slight damage although this was a major flood in adjacent watersheds. The destruction of the small dams at Cherryfield, expecially the dam at Stillwater, has resulted in conditions much more favorable to the formation of ice jams. This is the contention of local interests and it is strikingly borne out by the increased number of jams experienced since 1942, and the fact that no jams are recorded prior to 1936.

42. Ice Conditions. Ice conditions are a major factor in the regimen of the Narraguagus River. Surface ice generally forms 18 to 24 inches thick on the upper river and its tributaries, and on the lakes or ponds within the basin, during the winter months. The fast, turbulent water in the rapids at Cherryfield is especially conducive to the formation of frazil ice in large quantities. Due to the high density of frazil ice as compared with sheet ice, which contains entrained air, the frazil ice submerges readily and eventually accumulates underneath the sheet ice cover. This probably accounts for the reported ice thickness of seven to eight feet at the upper end of the five-mile tidal reach between Cherryfield and Millbridge. Ponds and reservoirs were more numerous at one time in the Narraguagus River Basin and tended to diminish the quantity of ice in the lower reaches of the river as little or no frazil ice passed through the pools and the sheet ice was retained within the reservoir areas until it rotted away or until after the breakup of the ice downstream.

Cherryfield is in a natural location for formation of major ice jams. The ice flows, moving through the open water or thin ice in the rapids at Cherryfield, will slow down and tend to jam in the vicinity of the bridge on U. S. Highway No. 1, at the head of the ice-covered tidal pool.

Ice conditions and ice control are also covered in Supplement II of Survey Report for Flood Control dated December 1, 1949.

No facts have been found which counteract the basic premise on which the proposed local protection plan is based - namely that the ice which forms the damaging ice-jams will be retained in the Cherryfield dam reservoir until it "rots" out in the Spring.

43. Atlantic Sea-run Salmon. The Narraguagus River stands among the first of the eight remaining Atlantic salmon streams in Maine. During 1959, 167 salmon were taken from the Narraguagus River. The importance of the Atlantic Salmon as a special resource cannot be over-emphasized. Since 1948 an average of 28% of the total annual production of salmon at the Craig Brook Federal Hatchery has been stocked in the Narraguagus River.

The spawning runs and angler catch of the Atlantic Salmon, are expected to fluctuate but increase steadily in future years. It is the opinion of the Atlantic Sea-Run Salmon Commission that the average annual catch of salmon in the Narraguagus River over the next 50 years will be more than twice and may be several times the annual average for the past 12 years.

The fishway which has been incorporated into the project structure in combination with the channelizing of the streambed for approximately 150 feet downstream from the fishway will provide conditions for the passage of salmon with a high degree of efficiency.

44. Solutions Considered. a. General. Consideration has been given to all practicable methods of solving the ice-jam flood problem in the Town of Cherryfield. Among the methods considered have been various types of dam construction for formation of an ice retention reservoir, permeable barriers to hold back damaging ice flows, diking of damage areas and annual remedial or preventive measures.

b. Low Dam. The construction of a low concrete or rock-filled timber crib dam at Stillwater would recreate the former Stillwater Reservoir. This would cause ice jams to occur at the head of the reservoir rather than in Cherryfield. Normally the reservoir would either retain the ice until it rotted away in the Spring or delay its downstream movement until after the breakup of the ice in the 5-mile tidal reach between Cherryfield and Millbridge. The dam would also tend to diminish the quantity of ice in the lower reaches of the river as little or no frazil ice passes through pools or reservoirs. In effect this method of solution is based on restoring the reservoir that existed prior to experiencing ice jams. A dam will spillway crest about seven feet above the stream bed would be roughly the equivalent of the original structure at Stillwater. It would form a pool about $3\frac{1}{2}$ miles long extending up the Narraguagus River and West Branch. The reservoir area is well suited to forming a cover ice sheet to retain ice flows. A 5-foot dam would pond the water only about a mile and a quarter up the stream.

Overflow dams of concrete or rock-filled timber crib construction were considered. It is believed that a simple overflow dam, without gate operation, would be highly effective in controlling ice and preventing jams in Cherryfield. See Sections Q and T for further details.

Dams on the Narraguagus River are considered a hazard to salmon and other migratory fish. Therefore a fishway is essential to mitigate fisheries damage from stream barriers. Each barrier considered has been modified where necessary to provide for the passage of fish.

45. Permeable Barrier. Two types of permeable dams were considered as an alternative to an overflow dam; a random rubble dam and a steel H-piling barrier.

a. The pond in back of a random rubble dam would remain low except in high-water periods when the structure would act much the same as an overflow dam. The retention of sheet ice in the reservoir would be less certain and in the absence of a permanent pool, ice pressure against the structure would be of frequent occurrence. It is doubtful if such a structure and its abutments could be made sufficiently stable to serve its purpose.

b. A steel H-pile barrier would cause an ice jam to form at the site. Such a structure would be experimental in nature with no certainty as to its effectiveness in controlling ice-jam floods.

It is believed that either type of permeable barrier has inherent uncertainties of behavior especially with regard to possible plugging and resulting scour which would them them uncontrollable and hence unsatisfactory. Due to the uncertainties connected with this type of structure, no detailed estimates of cost have been prepared.

46. <u>Dikes.</u> Protection from flood water could be provided by the construction of dikes along both banks of the Narraguagus River at Cherryfield. Nearly 1 - 1/2 miles of dike would be required and it would be necessary to relocate the Masonic Hall, Town Hall, Bank, and two other large structures that are situated on the river bank. Dikes would intensify the ice pressure applied by ice jams to the Route 1 Highway bridge to the point of possible failure. The cost of dike protection is estimated at $600,000 and would be slightly in excess of the fair market value of the property afforded security by the dikes. Protection of this nature was eliminated as an alternate protection method. See Section T for detail of costs.

47. <u>Annual Preventive Measures.</u> Consideration has been given to reducing the hazard of ice jams by annual remedial or preventive measures instead of constructing protective works of a permanent nature. Three methods may be employed, either separately or in combination. One method is to blast the ice jams as they occur, employing explosives such as dynamite.

Local interests on several occasions have employed dynamite to relieve ice jams at Cherryfield, and met with partial success. They claim that the jams form very suddenly, with very little advance notice. Owing to the fact that the greater part of the jam is grounded, considerable time is required to blast a free-flowing channel through the ice. It is reported that three days were required to blast a half-mile length of channel. Some years the river freezes the entire five-mile reach to Millbridge. There does not appear to be sufficient depth of water beneath the ice to carry out successful blasting operations.

A second method, the use of thermite is used widely in the northeastern section of the United States. The heat from reacted thermite produces a temperature which varies from 2500°C to 3500°C and is produced in a few seconds. The river is five miles long and unless this thermite is placed strategically the heat would dissipate without melting the ice. There is such a rapid evolution of gas that a slow explosion results, which has proved most effective in loosening and cracking ice masses. For ice control in thickly settled communities it offers no unpleasant or dangerous features. It can do no harm to concrete structures or bridge piers in immediate contact with the reacting thermite and no harm has ever been done to fish in rivers or lakes where it has been used. There are no detonating noises to break windows and the thermite is itself absolutely non-explosive and safe to handle.

The third method is to secure and maintain an open channel in the lower section of the river so that the ice coming down the stream would have a clear passage to the sea. This has been accomplished on some rivers by using cinders and chemicals, such as calcium chloride, to accelerate the deteriorationg and breakup of the ice in the Spring.

Explosives used in conjunction with cinders and chemicals might prove effective on the Narraguagus, but there is considerably uncertainty regarding the success of this method as compared with a permanent structure, particularly in the case of an unseasonable thaw such as that of January 1945.

The cost for annual preventive measures have been estimated at one and one-half times the annual cost of a timber-crib dam.

Q. PROPOSED IMPROVEMENT

48. General Description. Plate No. 5 shows a general layout of the recommended plan for a low rock-filled timber crib and earth fill dam to provide local ice-jam protection on the Narraguagus River in Cherryfield, Maine. The dam consists of a rock-filled timber crib spillway weir 140 feet in length and two non-overflow earth and rock fill sections about 150 feet and 200 feet in length. At each end of the spillway a 3.5 foot sluiceway with stoplogs is provided for maintenance purposes. Rock-filled timber crib abutments flank each side of the spillway forming the side walls of the spillway and retaining the embankment sections.

The east non-overflow portion of the dam consists of a rock-filled timber crib abutment 24.5 feet high, 51 feet long and 18 feet wide, and an earth and rock fill embankment section 130 feet long, with a maximum height of 18 feet and a top width of 14 feet. A Denil-type fishway is incorporated in this abutment crib. Eight foot wide wingwalls project 14 feet upstream and 23 feet downstream from the main crib.

The west non-overflow portion of the dam consists of a rock-filled timber crib abutment 24.5 feet high, 66 feet long and 16 feet wide and an earth and rock fill embankment section 180 feet long with a maximum height of 16 feet and a top width of 14 feet.

The river banks upstream and downstream for a distance of about 60 feet from the ends of the abutment timber cribs are protected from stream scouring and high spillway flows by a 2-foot layer of rock-fill bedded on 1 foot of gravel. Three independent rock-filled timber cribs are located about 125 feet upstream of the spillway that will aid in anchoring the reservoir cover ice in place. The individual cribs are placed in an arched pattern from abutment to abutment. These anchor cribs conform with experience at similar structures in Maine and Canada as verified by logging company engineers and river men.

49. Hydraulic Design

a. Weir. The crest of the planked weir was set at the approximate elevation of the old Stillwater dam, elevation 57.0 feet m.s.l. This will permit the development of 2 to 3 feet of sheet ice in the pool, which will act as a barrier to the upstream floating ice. The adopted length of 140 feet appeared to be a practical economic limit. A discharge coefficient "C" of 2.64 was used for the weir with a breadth of crest of 10 feet. (Table 51, Kings, Handbook of Hydraulics, Third Edition). This resulted in a head of 11.8 feet for the design discharge of 15,000 with resultant average velocities in the channel of 3 f.p.s. and 7 f.p.s. upstream and downstream respectively. Rating curves for headwater and tailwater conditions are shown on Plate No. 5 and water surface profile over the spillway for selected discharge are shown in Section C-C, Plate No. 6. The tailwater data was developed from the rating curve for the U. S. Geological Survey Gaging Station located approximately 1000 feet downstream of the dam site.

b. Fishway. - The Narraguagus River is considered to be one of the most important salmon streams in the State of Maine. A fishway is provided to permit the upstream movement of migratory fish. The design of the Denil-type fishway was based on standards supplied by the State of Maine and the U.S. Fish and Wildlife Service. The entrance to the fishway was modified so that the gate would raise free of the water and avoid a jet action. Alewives, which also use the river, will not swim through a jet. In considering movement of fish over the weir or through the sluiceways, it is understood that the larger migratory fish, such as the Atlantic salmon have difficulty moving upstream against velocities greater than 6 feet per second, or when required to jump a distance greater than 6 feet either a vertical or horizontal distance. The fishway design meets this criteria.

50. Geology, Earthwork, Rock-fill, Timber Cribs and Foundations.

a. General. A reconnaissance of the site and a study of the explorations and tests made prior to 1950 including grain size and falling head permeability tests on remolded samples, have been made to determine: (a) the characteristics of the foundation soils for the proposed dam, and (b) the characteristics of the materials which are to be used in the structures. The location of subsurface explorations are shown on Plate No. 5 and an engineering log profile of the dam foundation is shown on Plate No. 9. Soil explorations and soil tests made prior to 1950, were considered adequate for the design of the small earth embankments and rockfill timber cribs which constitute the proposed Cherryfield Dam.

b. Characteristics of Foundation Soil.

(1) Description and Distribution. The type of materials comprising the abutments were determined by two borings drilled in 1948. Boring BH-1 was made in the east abutment where the surface elevation is 57 feet, approximately 2 feet higher than the river level during normal flow. Boring BH-2 was made in the west abutment where the surface elevation is 62 feet. The following descriptions of the foundation soils are based on these two borings, results of grain size tests and geological history.

At the site, overburden materials, consisting mainly of relatively compact silty sandy gravel and silty gravelly sand, are present to a depth of some 45 feet in the valley bottom. Both abutment foundations have an intermediate zone of gray compact gravelly, silty sand extending from a depth of 7 and 12 feet at the west and east abutment, respectively, down to elevation 26 feet, which is 24 feet below the river bed. The soil in this intermediate zone contains silt sizes in the order of 25 percent, by weight, and varying percentages of gravel. Within the intermediate zone at the west abutment, a 5-foot layer of compact sandy silt exists at depth of 18 feet below ground surface. This intermediate zone probably extends under the river. Field observations indicate that the upper few feet in the river bed contain numerous cobbles, boulders, and remnants from old crib dams.

Overlying the intermediate zone at the west abutment, there is a 7-foot deposit of brown, loose silty sand containing 44 percent silt sizes. At the east abutment, the overlying deposit at river elevation consists of 12 feet of brown, medium compact gravelly silty sand with 24 percent silt sizes. At higher elevations immediately downstream of the east abutment, man made fills may be present in the area of the existing road. Underlying the intermediate deposit at both abutments, there is gray, compact silty medium to fine sand. Some gravelly phases occur in the west abutment within and below the intermediate zone. Grain size distribution of the various foundation soils is shown on Plate No. 10. An engineering log profile along the centerline of the dam is shown on Plate No. 9.

(2) Shear Strength and Settlement. Foundation soils except for the top zone at the west abutment, are compact and granular. Their strength is adequate to insure a stable foundation for the proposed structures. Although top deposit at the west abutment is in a loose state, the soil is granular and the shear strength is considered adequate. The structure loading is not great and any settle-

ments will be small in magnitude and will occur during construction.

(3) Permeability. Coefficients of permeabilities of the various pertinent zoil zones were selected from a study of exploration data, grain size distribution curves and from a few laboratory falling head permeability tests on remolded soil. On the basis of this study, it is considered that the foundation soil to a depth of approximately elevation 30 feet, has an effective coefficient of permeability ranging from 0.00001 to 0.0001 centimeters per second, except in the top 7 feet of the west abutment where the soil is a loose silty sand and has an effective coefficient of permeability in the order of 0.001 centimeters per second.

c. Bedrock. Bedrock encountered in both exploratory borings was a hard medium textured diorite. This rock is part of an extensive granitic body, the easterly margin of which, in this area, is in contact with gneisses and schists in the vicinity of the railroad bridge just upstream of the site.

d. Characteristic of Embankment and Rock Filled Timber-Crib Materials.

(1). Earth Fill Material. The material is to be used in the compacted earth fill section of the non-overflow portion of the dam, and in the dumped earth fill section of the timber crib spillway is a silty gravelly sand which will be obtained from a ridge deposit near the east abutment of the dam. A 20-foot exposed face exists in this deposit. Local information disclosed that this material has been used in the construction of an earth fill and timber crib dam. A mechanical analysis made on a representative sample obtained from the exposed face indicates a silt content of about 10 percent, by weight, and a gravel content of the material is below the optimum for compaction. It is expected that ground water will not be encountered within the required borrow excavation.

(2) Gravel Bedding Material. A field investigation disclosed that a suitable source of sandy gravel and crushed stone for bedding is not readily available within the immediate vicinity of the dam site. The required quantity of gravel bedding is very samll and will be obtained from a commercial source within 25 to 50 miles from the site. Further investigations will be made to determine

the character of this material from commercial sources to aid in the preparation of a practical specification.

(3). Crushed Stone. Specifications for crushed stone to be used for slope protection and for downstream embankment toe will be made in accordance with the State of Maine Standard Specifications, Highways and Bridges, requirement for course aggregate grading for Class B Concrete ($2\frac{1}{2}$" Max. size). Preliminary investigations have disclosed that the nearest commercial source of crushed stone is located about 50 miles from the site.

(4). Rockfill. There are no known actively producing rock quarries within a 15-mile radius of the project. There are, however, several abandoned granite quarries in the Town of Millbridge, some 4 to 5 miles south of the project. For the most part these quarries are little more than prospect holes, further development of which would entail roughtly the same procedures and costs as opening and operating a new quarry.

Active quarrying is being carried on at numerous locations in the Towns of Franklin and Sullivan, 15 to 20 miles west of the project. The rock in this area is a high quality granite and these operators are engaged principally in the production of cut stone. There may be a lack of desire on the part of any of these operators to produce rock for, and in the sizes required, for this project. There is however, considerable reserve of waste material at these operations, much of which will undoubtedly meet the project requirements for rock fill. Cut stone in the form of broken or misshapen blocks is also available in some quantity at these quarries, should the need for such material arise on this project.

The numerous cobbles and boulders which pave the river bed thorughout the project area are suitable for use as rock fill in cribs. The availability of this material would be hampered by high river flows. Use of these materials will be optional in the specifications.

Exposures of suitable granitic rock occur rather extensively in the coastal area south of the project and in the area between Cherryfield and Tunk Lake to the west. Many of these exposures present fair to good adaptability for the opening of a quarry should local protection become an alternate. The banded micaceous gneisses and schists which occur in a narrow belt trending roughly NR-SW through Cherryfield, are of poor quality and are not suitable.

(5). Rock Spalls. A rock quarry engaged in the production of cut stone located approximately 20 miles from the site has a stockpile of rock waste containing cobble sizes which could be used as rock spall. Other quarries in that general area also have similar stockpiles of rock waste. The rock spall material will be specified according to available satisfactory material and will in general consist of a mixture of stones with a maximum size of 6 inches.

(6). Timber. All of the material for the abutments and weir except the fishway will be of creosoted lumber with 12 to 16 pound treatment. The basic size of crib members is 8" X 8", which size was established in order to utilize the local timber product of Norway pine. The planking of the weir and sluiceways would also be Norway pine since it has reasonably good strength and will retain creosoting treatment to an excellent degree. The lining of the fishway as well as the baffles will be of untreated spruce, Norway pine, white pine or hemlock, all of which are available locally.

e. Design of Earth Fill Embankment and Rock-Filled Timber Cribs.

(1) General. Cherryfield Dam will consist of one overflow and two non-overflow portions. A layout of the dam and appurtenant works is shown on Plate No. 5. The overflow portion of the dam consists of a rock-filled timber crib weir. The non-overflow portion of the Dam consists of two compacted earth fill embankments and two rock-filled timber crib abutments. The design is predicated on economically available earth fill with adequate seepage control and slope protection.

(2) Description of Earth Embankments. The earth embankment consists of a homogeneous section of compacted earth fill. The outer slopes of the embankment are 1 vertical on 2 horizontal except the downstream slope below elevation 67.5 feet where it flattens to 1 vertical to $2\frac{1}{2}$ horizontal. The maximum embankment height is about 17 feet and the top width is 14 feet. The freeboard is 3.7 feet. The upstream slope is protected by 2 feet of rock fill on 12 inches of gravel bedding. The downstream sloped above elevation 67.5 feet is protected by a 12-inch layer of crushed stone, and below elevation 67.5 feet, the slope protection is provided by a crushed stone section. An inspection trench 5 feet in depth is provided in a reach on the west abutment to determine if any objectionable fill material exists in the foundation area.

(3) Description of Rock-Filled Timber Crib Structures.

The river and abutments will be of timber construction, all of which will be creosoted to a 12- to 16-pound treatment except the baffles and lining of the fishway. The fundamental designs follow the idea of the rock-filled timber cut structures that have been in common use in this general area for many years. The general basic design covers the use of 8" X 8" rough, creosoted timber fastened at each bearing with 2-5/8" X 15" drift bolts. The sides and upstream ends of the abutment cribs will have solid faces by using 8" X 8" fillers between the crib members. The weir with its sluiceways will be surfaced with two layers of cresoted planking. The upstream toe of the river will be protected with an earth embankment armored with a rock surface and a filter layer, white. The downstream toe will have the protection of a 2-foot blanket of rock underlain by a 1-foot layer of rock spalls. These rock blanket areas will tie in with the shore slope protection.

(4) Slope Protection. The upstream slopes of the embankments will be protected against frost sloughing, wave action and stream scouring by 14 inches of rock fill over 12 inches of gravel bedding. The downstream slope of the embankments will be protected against frost sloughing, run-off erosion and tailwater scouring by 12 inches of crushed stone above El. 67.5 and below this elevation the protection will be provided by the crushed stone section of the embankment. The crushed stone will be the same as the filter material for the downstream pervious section.

(5) Seepage Control.

a. Through Seepage. The earth fill is to be used in the compacted fill section of the embankment has a coefficient of permeability of about .0001 cms per second and it is expected that a steady seepage stage will be attained during a flood stage. The embankment through seepage will be controlled by a downstream crushed stone section. Crushed stone has been provided since it serves as a pervious material, a filter material and suitable material for slope protection. The rock-filled cribs will be sheeted to minimize the through flow. The dump fill section upstream of the rock fill cribs has been provided to minimize the seepage velocity through the cribs and also to increase the seepage path along the base of the cribs.

b. Foundation Seepage. Adequate seepage control through the foundation is provided by a downstream toe of crushed stone and a foundation cut-off of compacted earth through the loose surface deposit on the west abutment. A layer of rock spalls has been provided beneath the rock fill in the cribs to prevent piping of the foundation soils.

(6) Stability.

a. Foundation Stability. Structure loads are light and will not overstress the foundation soils.

b. Embankment Stability. The embankment height is small and the earth fill to be used in the compacted section of the embankment is granular and fairly well graded. Ample stear strength is available for all loading conditions.

f. Permanent Cut Slopes.

(1). Earth Cuts.

a. River Banks. Earth cuts made along the river banks will be protected from stream scouring with a 2-foot layer of rock fill backed by a 12-inch layer of gravel bedding. This protection is satisfactory for the computed velocity of 8 feet per second, according to Corps of Engineers standards.

b. Borrow Areas. Permanent cut slopes in the borrow areas will be topsoiled and seeded.

51. Structural Design.

a. Purpose. This section of the design memorandum presenta the design criteria, basic data and assumptions and design of the rock filled crib dam and abutments. Computations are included in Appendix A showing design conditions investigated.

b. Design Criteria.

(1) General. All working stresses conform to those specified in the Engineering Manual EM 1110-1-2101, "Working Stresses for Structural Design", dated 6 January 1958. Loading conditions, design assumptions and other criteria have been based on applicable parts of Gravity Dam Design (EM 1110-2-2200, Sept. 1958) and Structural Design of Spillways and Outlet Works (Part CXXIV, Dec. 1952). Accepted engineering practice has been employed in cases

where the Engineering Manual for Civil Works does not apply.

(2) Timber. The following table lists the timber stresses used in the design of the structures.

Flexure	Lbs. per sq. in.
Extreme fiber stresses in tension	1,100
Extreme fiber stresses in compression	775
Shear	
Horizontal shear	75
Modulus of Elasticity	1,320,000

(3) Increase in Normal Working Stresses. No increase in normal working stresses has been made.

c. Basic Data and Assumptions.

(1) Controlling Elevations

Top of Dam	72.5
Spillway Crest	57.0
Maximum Surcharge Elevation	68.8
Maximum Tailwater Elevation at Spillway	63.0
Elevation of Stream Bed (excavated)	48.0

(2) Loads.

a. Dead Loads. The following unit weights of materials have been used.

Material	Unit Weight (lbs/cu.ft.)		
	Dry	Saturated	Submerged
Dike Fill	115	125	62.5
Rock Fill	111		70
Wood	12.5		

b. Live Loads. The following live loads have been used:

Water	62.5 lbs. per cu. ft.
Wind	30 lbs. per sq. ft.

(3) External Water Pressure. Hydrostatic uplift pressure has been assumed at the full external head over the entire base area because of the nature of the base. Computations have been prepared on the basis of submerged weight of materials and no uplift pressures.

(4) Earth Pressure. Earth pressures used against the abutments have been determined in general in accordance with Part X, Structural Design, Chapter 9, Retaining Walls. "At Rest" pressures have been used where embankment is against the abutment.

(5) Earthquake Forces. The effect of possible earthquake forces on the structure is considered slight and has, therefore, been disregarded in the design.

(6) Ice Pressure. An ice thrust of 5,000 lbs. per linear foot has been used in the design of the weir. Ice locking piers will be provided upstream to hold the sheet ice. These piers will be of similar construction to others already in existence in this area.

(7) Location of Resultant. The resultant of the horizontal and vertical forces has been held to the middle third of the base for all conditions of loading.

(8) Factor of Safety Against Sliding. A coefficient of friction on the base was found to not exceed 0.35, which is considered adequate.

d. West Abutment. The west abutment will be a rock filled crib 66 feet long, 24.5 feet high and 16 feet wide. It was analyzed for the following two conditions of loading:

Case I. Rapid drawdown condition using a saturated soil pressure for the dike.

Case II. Maximum flood condition with water at El. 66.0. Submerged weight below this elevation and saturated weight above.

e. East Abutment. The east abutment is 51.0 feet long, 24.5 feet high, 18.0 feet wide and contains a fish ladder. It has been analyzed for the same conditions of loading as the west abutment. Horizontal ties spaced 8' - 0" horizontally and 1' - 4" vertically have been designed to transmit the trust between the two sections and will tie the structure together.

f. Spillway Weir. The spillway weir is a rock filled crib structure 140 feet long with a plank face. It has been analyzed for maximum flood condition as well as an ice thrust of 5,000 lbs. per linear feet applied to 1 foot down from the crest. The plank deck and its fastenings will be capable of withstanding a 5 foot differential head which is considered conservative.

R. MULTIPLE-PURPOSE FEATURES

52. General. Limited consideration has been given to the use of a multiple-purpose reservoir at the former Stillwater site for increased low water flow during the Salmon migration season, reducing flood flows, recreation, power development and/or water supply.

53. Low-flow Regulations. Regulation of the reservoir to increase stream flow during low periods while apparently appearing desirable for aiding or increasing the upstream movement of fish actually has several disadvantages:

a. If the flow were increased and did attract fish up to and through the dam the low flow into the reservoir might not permit the fish to reach the spawning beds. This would defeat the purpose of increasing the low flow below the dam. Fishery biologists have stated that worthwhile low flow increase regulation must originate in the upper reaches of a river basin.

b. Responsibility for operation of the dam and sluiceways would entail further expense and operational difficulties.

c. Yearly lowering of the reservoir surface would increase the maintenance cost due to faster deterioration of timber members.

d. Increase in cost of project without sponsor for financing of feature.

e. Use of pool for recreational purpose would be adversely affected.

54. Flood Control. The Stillwater site appears from inspection to be suitable for the construction of a dam 30 to 40 feet above the stream bed. Twelve or more sets of buildings and about five miles of highway would be affected. The capacity of such a reservoir would be over 50,000 acre-feet or 4.0 inches 230 square miles of drainage area. This capacity is not required or justified for the present flood-control needs of Cherryfield.

55. Power Development. Power storage at the site in conjunction with a penstock, a headwater reservoir on Barrel Brook and a power station 1000 feet below the railroad bridge to obtain a gross head of 40 feet would develop a power potential of 9,000,000 kilowatt hours. The power potential is not practicable of economic development and is not desired by local interests. The Federal Power Commission by letter dated March 7, 1960, states that power development is not practicable or economical.

56. Water Supply. The provision of water supply in a multi-purpose project is presently not desired by the Town of Cherryfield as it is not in a position to finance such a project.

S. RECREATIONAL DEVELOPMENT

57. General. One of the main features of the project is the incorporation of a Denil-type fishway in order to mitigate adverse effect of the dam or passage of migratory fish, especially Atlantic Salmon and Alewives. Non-Federal agencies are required to furnish all project lands and rights-of-way required, therefore, all use of the project including recreational use will be in the jurisdiction of the Town of Cherryfield. The type and design of the fishway has been approved by the State of Maine Department of Inland Fisheries and Game. The United States Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, report (Exhibit No. 12) discusses this subject in detail.

T. ESTIMATES OF FIRST COST AND ANNUAL CHARGES

Estimates of Federal and non-Federal first costs and annual charges are given in Tables 7, 8, and 9. These estimates have been prepared on the basis that local interests would bear the entire cost of relocations and alterations to utilities, furnish all lands, water rights and rights-of-way necessary for construction and operation of the project including borrow and disposal areas for excavated materials not used in the dam, and operate and maintain the project after completion.

Unit prices used in estimating costs are based on average bid prices for similar work in the same general area. The prices are based on 1960 price levels and include minor items of work which are not separately detailed in the cost estimates. Annual charges are based on an annual Federal interest rate of 2.5 percent and non-Federal interest rate of 3.5 percent with amortization over a 50-year period. A summary of first costs and annual charges for a rock-filled timber crib and earth fill dam are given in Table 7. Table 8 and 9 respectively are summarizations of first costs and annual charges for alternates of a concrete and earth fill dam and a protective dike.

TABLE 7

NARRAGUAGUS RIVER, CHERRYFIELD, MAINE

COST ESTIMATE FOR ROCK-FILLED TIMBER CRIB AND EARTH-FILL DAM

FIRST COST
(1960 Base)

FEDERAL

Item	Quantity	Unit	Unit Cost	Amount
Stream Control		Job	L. S.	$ 2,700
Clearing and Grubbing	1	Acre	$500.00	500
Stripping	1,000	c.y.	.40	400
Earth Excavation	4,000	c.y.	.75	3,000
Earth Borrow	2,000	c.y.	1.00	2,000
Rock Facing	1,500	c.y.	4.00	6,000
Gravel Bedding	550	c.y.	4.00	2,200
Crushed Stone	750	c.y.	7.00	5,250
Crib Timber, creosoted	180	mfbm	325.00	58,500
Crib Planking, "	35	mfbm	325.00	11,480
Misc. Lumber, untreated	8	mfbm	275.00	2,200
Fishway Gate		Job	L. S.	2,500
Stoplogs	.5	mfbm	250.00	125
Crib Rock Fill	2,500	c.y.	5.00	12,500
Rock spalls	650	c.y.	5.00	3,250
Sub-total				$ 112,600
Contingencies @ 20%				22,400
Construction Cost				135,000
Engineering and Design				26,000
Supervision & Administration				14,000
Total Estimated Federal First Cost				$175,000

NON-FEDERAL

Item	Amount
Land Acquisition, easements & rights-of-way	$ 3,500
Total Estimated Non-Federal First Cost	3,500
Total Estimated Project First Cost	$ 178,500

ANNUAL CHARGES

FEDERAL

Interest (2.625 x $175,000)		$4,594.00	
Amortization (.989% x $175,000)		1,989.00	
Total Federal Annual Charges			$5,583.00

NON-FEDERAL

Interest (3.5% x $3,500)		120.00	
Amortization (.763% x $3,500)		30.00	
Maintenance:			
Decking replacement (20 years)	$290.00		
Fishway replacement (10 years)	220.00		
General annual maintenance	300.00		
Total Maintenance		810.00	
Loss of Taxes		200.00	
Total Non-Federal Annual Charges			1,160.00
TOTAL ANNUAL CHARGES			6,743.00

Benefit-Cost Ratio = $\frac{\$13,000}{6,743}$ 1.9 to 1.0

TABLE 8

NARRAGUAGUS RIVER, CHERRYFIELD, MAINE

COST ESTIMATE FOR CONCRETE AND EARTH FILL DAM

FIRST COST
(1960 Base)

FEDERAL

Item	Quantity	Unit	Unit Cost	Amount
Stream Control		Job	L. S.	$ 5,000
Clearing and Grubbing	1	Acre	500	500
Stripping	900	c.y.	.40	360
Earth Excavation	3,500	c.y.	1.00	3,500
Earth Borrow	2,500	c.y.	1.00	2,500
Rock Facing	1,250	c.y.	4.00	5,000
Gravel Bedding	500	c.y.	4.00	2,000
Crushed Stone	650	c.y.	7.00	4,550
Fishway Gate		Job	L. S.	2,500
Stoplogs	.5	mfbm	250.00	125
Concrete Spillway	1,040	c.y.	61.00	63,440
Concrete Abutments & Fishway	1,130	c.y.	59.00	66,470
Reinforcing	20,000	lbs.	.15	3,000
Sub-total				$158,950
Contingencies @ 20%				31,750
Construction Cost				$190,700
Engineering and Design				30,000
Supervision and Administration				17,000
Total Estimated Federal First Cost				$237,700

NON-FEDERAL

Item	Amount
Land Acquisition, Easements and Rights-of-Way	$ 3,500
Total Estimated Non-Federal First Cost	3,500
Total Estimated Project First Cost	$241,200

ANNUAL CHARGES

		Amount	
FEDERAL			
Interest (2.625 x $237,700)		$6,240	
Amortization (.989% x $237,700) .757		2,350	
Total Federal Annual Charges			$8,590.00
NON-FEDERAL			
Interest (3.5% x $3,500)		120.00	
Amortization (.763% x $3,500)		30.00	
Maintenance:			
Concrete Features (.1%)	160		
General Maintenance	200		
Total Maintenance		360	
Loss of Taxes		200	
Total Non-Federal Annual Charge			710
TOTAL ANNUAL CHARGES			9,300.00

Benefit-Cost Ratio = $\frac{\$13,000}{9,300}$ 1.4 to 1.0

TABLE 9

NARRAGUAGUS RIVER, CHERRYFIELD, MAINE

COST ESTIMATE FOR PROTECTIVE WORKS (RIVER-BANK DIKES)

FIRST COST
(1960 Base)

FEDERAL

Item	Quantity	Unit	Unit Cost	Amount
Clearing and Grubbing	4	Acres	350.00	$1,400
Stripping	11,900	c.y.	1.00	11,900
Armor Stone (hand placed)	13,300	c.y.	8.00	106,400
Crushed Stone (bedding)	12,300	c.y.	7.00	86,100
Gravel	2,100	c.y.	4.00	8,400
Crushed Stone (filter)	4,900	c.y.	7.00	34,300
Earth Borrow	46,600	c.y.	1.00	46,600
Culvert (24")	224	I.F.	8.00	1,690
Flap gates (24")	4	Ea.	750.00	3,000
Stoplog Structures (2)		Job	L.S.	80,000
Sub-Total				$379,790
Contingencies @ 20%				75,910
Construction Cost				$455,700
Engineering and Design				50,000
Supervision and Administration				42,000
Total Estimated Federal First Cost				$547,700

NON-FEDERAL

Item	Amount
Land and Buildings Acquisition, Easements and Rights-of-Way	60,000
Total Estimated Non-Federal First Cost	60,000
Total Estimated Project First Cost	$ 607,700

ANNUAL CHARGES

	Amount	
FEDERAL		
Interest (2.625 x $547,700)	$14,377	
Amortization (.989% x $547,700)	5,417	
Total Federal Annual Charges		$19,794
NON-FEDERAL		
Interest (3.5% x $60,000)	2,100	
Amortization (.783% x 60,000)	460	
Maintenance	500	
Loss of Taxes	2,000	
Total Non-Federal Annual Charges		5,060
TOTAL ANNUAL CHARGES		24,854

Benefit-Cost Ratio = $\frac{\$13,000}{24,854}$ 0.5 to 1.0

TABLE 10

NARRAGUAGUS RIVER, CHERRYFIELD, MAINE

COST ESTIMATE FOR ALTERNATE PLAN (200' SPILLWAY) TIMBER CRIB DAM

FIRST COST
(1960 Base)

FEDERAL

Item	Quantity	Unit	Unit Cost	Amount	Total
Div. & Care of River		Job	L.S.		3000
Clearing and Grubbing	1	Acre	$500.00	$ 500.00	500
Stripping	1000	c.y.	.40		400
Earth Excavation	12000	c.y.	.75		9000
Earth Borrow	0				0
Rock Facing	1750	c.y.	5.00		8750
Gravel Bedding	750	c.y.	4.00		3000
Crushed Stone	600	c.y.	7.00		4200
Crib Timber, creosoted	220	mfbm	325.00		71500
Crib Planking, creosoted	60	mfbm	325.00		19500
Misc. Timber, untreated	10	mfbm	275.00		2750
Fishway Gate and T.R.		Job	L.S.		2500
Stop logs, creosoted	.5	mfbm	250.00		125
Crib Rock Fill	3500	c.y.	5.00		17500
Rock Spalls	900	c.y.	5.00		4500
		Sub-Total			$147,225
Contingencies @ 20%					29,775
					177,000
Engineering and Design					26,000
Supervision and Administration					14,000
		Total Estimated Federal First Cost			$217,000

NON-FEDERAL

Item	Amount	
Easements and Rights of Way	$ 3,500	
Total Estimated Non-Federal First Cost		3,500
Total Estimated Project First Cost		$220,500

ANNUAL CHARGES

FEDERAL

Interest (2.625% x 217,000)	$5700.00	
Amortization (.989% x 217,000)	2146.00	
Total Federal Annual Charges		$7846.00

NON-FEDERAL

Interest (3.5 x 3500)		120.00	
Amortization (.763% x $3500)		30.00	
Maintenance:			
General Maintenance	$644.00		
Loss of Taxes	200.00		
Total Maintenance		844.00	
TOTAL ANNUAL CHARGES			$8,690.00

Benefit Cost Ratio = $\frac{\$13,000}{8,690}$ 1.5 to 1.0

U. ANNUAL BENEFITS

Annual flood damage prevention benefits have been derived as the difference in annual losses under present conditions and those remaining after construction of the project. Annual losses have been developed for ice-jam floods having a frequency of more than once in one hundred years. All losses in this range will be eliminated by the recommended project, thus developing annual benefits of $13,000.

Lands available for industrial, commercial and other development are available at the edge of the village outside of the flood area. To date, there has been little development of these areas. There have been only three structural renovations and one new structure erected in the flood area in recent years. In view of the economic decline of the community over a considerable number of years, it is not anticipated that flood protection will significantly affect development of the flood area. Appendix C includes a fuller discussion of annual benefits.

V. COMPARISON OF BENEFITS AND COSTS

Average annual benefits for the Cherryfield Local Ice-Jam Flood Protection Project are estimated at $13,000 and average annual costs are estimated at $6,743. The resulting ratio of benefits to cost is 1.9 to 1.0.

W. PROJECT FORMULATION AND ECONOMIC JUSTIFICATION

GENERAL. The Division Engineer finds that ice jam floods have caused considerable damage in recent years on the Narragaugus River in Cherryfield, Maine and that these floods are of more frequent occurrence since the failure and abandonment of several small dams. He concludes that construction of a low rock filled timber crib would relieve the difficulty from ice jams at Cherryfield, Maine.

Four types of design were considered:

a. Rock filled timber crib and earth fill dam.

b. Concrete and earth fill dam.

c. Protective Works (River-Bank Dikes)

d. Rock filled timber crib with overflow weir across the channel.

Average annual benefits, average economic costs and the ratios of benefits to costs are summarized below:

Item	Project	Annual Benefits	Annual Costs	B/C Ratio
1.	Rock filled timber crib and earth filled dam	$ 13000	$ 7550	1.9 to 1
2.	Concrete and earth fill dam	13000	9090	1.4 to 1
3.	Protective Works(River Bank Dikes)	13000	24370	0.5 to 1
4.	Rock filled timber cut with overflow weir completely across the channel	13000	8920	1.5 to 1

All alternate studies proved more costly than (Item No. 1) rock filled timber crib and earth filled dam, the recommended plan.

X. SCHEDULES FOR DESIGN AND CONSTRUCTION

58. Design. It is estimated that preparation of contract plans and specifications for the project will require two months. The estimated cost is $9,000.

59. Construction. Construction of the project can be accomplished in one construction season of four months duration under a single contract, except for minor seeding work which could be accomplished the following spring. All funds for the design and construction of the project should be available for obligation prior to award of the contract to permit completion in one construction season which includes portions of two successive fiscal years. Federal expenditures are estimated as follows:

FISCAL YEAR 1960

Allotments to date (Detailed Project Report)	$15,000
FUTURE WORK	
Planning	9,000
Construction	151,000
Total Future Work	160,000
TOTAL	$175,000

Y. OPERATION AND MAINTENANCE

Maintenance of this project will be the responsibility of the local interests (See Section 25). Periodic inspections will be made to assure that adequate maintenance is performed in accordance with regulations prescribed by the Secretary of the Army. It is estimated that maintenance of the project will cost local interests $810.00 annually. An operation and maintenance manual will be provided to the Town of Cherryfield.

Z. LOCAL COOPERATION

In accordance with Public Law 685, 84th Congress, adopted 11 July 1956, local interests would be required to provide without cost to the United States all lands, easements and rights-of way necessary for the construction and operation of the project; hold and save the United States free from damages due to construction work; and maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army. The responsibility for furnishing disposal areas for excavated materials not used in the dam and for the relocation or modifications of highways and utilities would rest with local interests under the requirements of lands, easements, and rights-of-way. Local interests would also be required to furnish the added assurance that they would contribute to the United States all necessary funds over and above the Federal cost limitation of $400,000 if it is later found that the total construction cost would exceed that amount.

Federal, State and Town Officials, and many private citizens of Cherryfield have indicated a strong desire for the construction of an ice-jam flood control protection project in Cherryfield. State and Town officials have indicated a willingness to fulfill conditions of local cooperation. Letters from the State and Town authorities which constitute preliminary assurances are attached as Exhibits 2,3 and 4. On March 14, 1960 the Town of Cherryfield voted to comply with the requirements for local cooperation as stated in the Flood Act of 1936 and Public Law 685.

A-1 COORDINATION WITH OTHER AGENCIES

Plans for the local protective works in Cherryfield have been reviewed by the Town of Cherryfield, State of Maine,Department of Inland Fisheries and Game, Maine State Highway Commission, U.S. Fish and Wildlife Service, U.S. Department of Agriculture - Soil Conservation Service, U.S. Bureau of Public Roads and the Federal Power Commission. Notice of Public Hearing was sent to all interested parties. Copies of comments from the agencies and others are included as Exhibits in this report.

60. Fish and Wildlife Resources. - A draft copy of the Detailed Fish and Wildlife Report on the Cherryfield Dam and Reservoir was furnished this office on 8 April 1960. The report was prepared by the U.S. Fish and Wildlife Service in cooperation with personnel of the Maine Department of

Inland Fisheries and Game and the Maine Atlantic Sea Run Salmon Commission. Transmittal of the formal report has not been made but the regional office of the U.S. Fish and Wildlife Service advises that no significant change is anticipated.

The report states that the varied habitat of the Narraguagus River Drainage which includes natural lakes, marsh ponds, beaver ponds, tributary streams and the main stream, supports a varied fishery resource. The Atlantic Salmon is by far the most important fish species in the drainage. It utilizes the river and its tributaries for spawning; lakes, ponds and deep river pools for overwintering; and the larger tributaries and river area for development as "parr" before descending to the ocean as two year old "smolt".

The Narraguagus River stands among the first of the eight remaining Atlantic Salmon streams of Eastern United States. Since the destruction of three dams in Cherryfield in 1942, the river has provided unobstructed passage to salmon upstream to Beddington, about 25 miles above the mouth. Destruction of the remains of the Beddington Lake Dam in 1951, has opened additional tributary streams for salmon use. This has resulted in an increase in the runs and catches of salmon.

Construction of the proposed dam will constitute a setback to salmon restoration efforts by the Federal Government and the State of Maine. Official interest and concern for the welfare of the Atlantic salmon has existed for nearly three quarters of a century. The Fish and Wildlife Service and its predecessors have maintained a salmon hatchery at Craig Brook since 1889. Based on recent annual operational costs at this station, salmon stocked in the Narraguagus River represents an annual investment of more than $11,000 by the Federal Government. In addition, it is estimated that the State of Maine has an investment probably in excess of $50.00 in each salmon caught in Maine. When the investments of individual anglers are added to the above, each Atlantic salmon caught presently represents an estimated investment of $250.00.

In order to minimize the adverse effects of the proposed construction on the valuable fishery resource of the Narraguagus River, the report makes the following specific recommendations and notes that unless they can be accepted in their entirety, the Bureau of Sports Fisheries and Wildlife of the U. S. Fish and Wildlife Service will have no alternative but to oppose the project.

(1). That a Denil-type fishway approved by the Maine Atlantic Sea Run Salmon Commission and costing an estimated $7300 be incorporated into the project design.

(2). That channeling of the streambed along the left bank of the river for a distance of approximately 150 feet downstream from the fishery be included as a project feature at an estimated cost of $200 with exact location, length, width and depth of the channel and deposition of spoil being determined at the site by representatives of the Maine Atlantic Sea Run Salmon Commission in cooperation with the Corps of Engineers.

(3). That the responsibility of the Township of Cherryfield for maintenance of the project subsequent to construction be defined to include maintenance responsibility for the fishway and the channeled streambed downstream from the fishway at an estimated annual cost of $300 with determination of annual maintenance needs and supervision of maintenance work primarily by the Atlantic Sea Run Salmon Commission in cooperation with the Corps of Engineers and the Town of Cherryfield.

(4). That additional detailed studies of fish and wildlife resources affected by the project be conducted as necessary during further planning and construction phases of the project to form the basis for such reasonable modifications for the conservation and development of fish and wildlife resources as may be desirable to obtain maximum overall project benefits.

(5). That additional modifications to achieve maximum project benefits be made in project facilities or operations, subsequent to completion of construction as may be desireable to obtain maximum overall project benefits, on the basis of Follow-up Studies by this Bureau to improve or supplement measures taken for the conservation and development of fish and wildlife resources, notwithstanding Paragraph (g) Section 2 of the Fish and Wildlife Coordination Act.

The comments of this office on the foregoing specific recommendations follow.

(1) This office has incorporated a Denil-type fishway in the project design at an estimated cost of $7300. Approval of this feature is contained in letter dated 15 Feb. 1960 from the Maine Department of Inland Fisheries and Game which reflects the views of the Maine Atlantic Sea Run Salmon Commission. This letter is included as Exhibit No. 1.

(2) At the request of Mr. Richard E. Cutting, who set forth the views of the Maine Atlantic Sea Run Salmon Commission and the Maine Department of Inland Fisheries and Game, a channel with a bottom elevation of about 47 feet m.s.l. at the downstream entrance to the fishway is provided. This channel will extend along the left bank of the stream about 150 feet downstream from the fishway with a depth of not less than two feet below the present river bed and with a bottom width of ten feet. The excavated material will be deposited between the channel and the right bank of the stream in a manner which will tend to divert flows into the channel at low flow periods. The estimated cost of this improvement is $200.

(3) The Flood Control Committee of the Town of Cherryfield has furnished assurance by letter dated 27 April 1960 that the improvements described above are accepted for maintenance by the Town of Cherryfield as an integral part of the project at an estimated annual cost of $300. The letter is included as Exhibit No. 13.

(4) and (5). Consistent with the spirit of the Fish and Wildlife Coordination Act (P.L. 85-624), additional

detailed studies of the fish and wildlife resources affected by the project are encouraged. This office will cooperate in the implementation of any measures within our authority. The provision of project lands and the maintenance and operation of the project, however, will be functions of the Town of Cherryfield.

AA. CONCLUSIONS

Investigation and studies for the local protection project covered by this report lead to the following conclusions:

(a) The Town of Cherryfield is faced each spring with the threat of damaging major floods caused by ice jams in the Narraguagus River in the vicinity of the U. S. Highway No. 1 bridge. The desires of the local inhabitants are for the best form of protection consistent with fisheries requirements.

(b) Although a system of local protection dikes would probably best serve the conflicting interests of flood control and an open river for passage of migratory fish it would not be economically justified and presents yearly operation problems of diverted highway travel.

(c) A barrier to hold ice formed above Stillwater site is the most practical method of relieving the threat of major ice jam floods. A rock-filled timber crib dam is the most economical method for positive improvement. Although construction of a dam will undoubtedly have some effect on fish runs much effort has been spent in obtaining the latest thinking and design for the dam fishway to minimize damage to fisheries. The project is economically justified by a ratio of annual benefits to annual costs of 1.8 to 1.0.

(d) The threat of recurrent damaging floods makes desirable construction of the project as soon as possible.

BB. RECOMMENDATIONS

It is recommended that the project, as submitted in this report, be authorized by the Chief of Engineers under the provisions of the Flood Control Act of 1948, as amended, and that additional funds be allotted in the amount of $9,000 for planning and $151,000 for construction.

APPENDIX A

Index to Design Computations

APPENDIX B

(LETTERS OF CONCURRENCE AND COMMENT)

Exhibit No.	Agency	Letter Dated
	CONCURRENCE AND APPROVAL	
1	Maine Department of Inland Fisheries and Game, Augusta, Maine	15 Feb 60
2	State of Maine, Office of the Governor, Augusta, Maine	16 Feb 60
3	U. S. Army Engineer Division, New England (To Governor of Maine)	25 Feb 60
4	Chairman, Flood Control Committee, Town of Cherryfield, Maine	23 Mar 60
4A	State of Maine, Office of the Governor, Augusta, Maine	7 Oct 60
	COMMENT	
5	United States Department of Agriculture, Soil Conservation Service	12 June 59
6	State Highway Commission, State of Maine	26 Aug 59
7	U. S. Department of Commerce, Bureau of Public Roads, Region One	18 Sep 59
8	Cherryfield Rod and Gun Club, Cherryfield, Maine	4 Nov 59
9	Office of Selectmen, Town of Cherryfield, Maine	12 Dec 59
10	Narraguagus Salmon Association, Cherryfield, Maine	12 Dec 59
11	Federal Power Commission, 139 Centre Street, New York 13, N.Y.	7 Mar 60

11 a	Federal Power Commission, Location Plan - Possible Future Power Plant below Proposed Charryfield Dam	Mar 60
12	U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Boston, Mass.	Apr 60
13	Town of Cherryfield, Flood Control Committee	27 Apr 60

APPENDIX C

1. Extent and Character of the Flooded Area. Approximately 50 acres of improved land along both banks of the Narraguagus River are affected by flooding in Cherryfield. Twenty-five homes and 3 public buildings are located in the flood area, with nearly equal distribution along both banks of the reach between the Maine Central Railroad bridge and the small brook which enters tidewater about 1,800 feet downstream from the Machias Road Bridge, U.S. Route 1. Nearly one-half of the commercial establishments and all four of the industrial firms in this small village of about 900 people are situated in or near the central village area which has experienced serious inundations from ice-jams on the lower Narraguagus River. Over 20 business establishments, including 10 stores, a bank, blacksmith, barbershop, service station, auto agency, oil distributor, 2 lodge organizations and 2 commercial warehouses, are vulnerable to flooding in this area. The majority of these firms are located in the central business district on the left bank in the vicinity of the Route 1 bridge. The two largest industrial firms in the village operate part-time cannery operations during the cherry and berry harvesting seasons. In recent years, these firms have imported and packed non-native fruits in order that operations could be continued throughout the year.

2. Damage Surveys. A detailed damage survey was made in the flood area immediately after the flood of April 1959. The results of the survey were correlated with data obtained by local officials after the 1942 flood. The 1959 survey consisted of a door-to-door inspection of all residential, commercial, industrial and public properties affected by the flood, as well as properties which would be affected by floods up to three feet higher. Information obtained included the extent of the areas flooded, description of properties, the nature and amount of damages, depths of flooding, high-water references, and relationships between the 1959 flood and other flood stages. Damage estimates were generally furnished by property owners or tenants, although some estimates were modified by the investigators when, in their judgment, estimates of owners or tenants were unrealistic or incomplete. Valuable information was also obtained from local and State officials and from other central sources.

Sufficient data were obtained to derive loss estimates for (1) the 1959 flood crest, (2) a stage 3 feet above the 1959 crest and (3) intermediate stages where marked changes in damage occur. The stage at which damage begins, referenced to the 1959 flood, was also determined.

3. Loss Classification. Flood loss information was recorded by type of loss and by location. Loss types recorded included urban (residential, commercial, and public), industrial, railroad and highway.

Primary losses have been classified as physical and nonphysical. Physical losses comprise primary losses such as damage to structures, machinery, and inventories and the cost of cleanup and repairs. Nonphysical losses include unrecoverable loss of business, wages or production, increased cost of operation and cost of temporary facilities.

Physical damage and a large part of the related nonphysical losses were determined by direct inspection of property and evaluation of losses by property owners, tenants and field investigators. Where nonphysical losses could not be determined on the basis of available information, estimates of such losses were based upon relationships between physical and nonphysical losses for similar properties in the area. The distribution of the total flood loss experienced at Cherryfield in April 1959 is shown by type of damage in Table C-1.

TABLE C-1

EXPERIENCED FLOOD LOSSES
Flood of April 1959
Cherryfield, Maine

Residential	$24,000
Commercial	83,000
Public	4,000
Industrial	1,000
Water Supply Wells	4,000
Highway	35,000
Railroad	-
TOTAL	$151,000

4. <u>Recurring and Preventable Losses.</u> There has been essentially no change in the flood area since the 1959 survey. A recurrence of 1959 stages would cause damages estimated at $143,000 at 1960 price levels. Estimates have been made of the recurring damages that would be experienced with various flood stages above and below the 1959 flood level. A recurrence of the stages experienced in the ice-jam floods of March 1936 and March 1942 would cause losses of $53,000 and $325,000, respectively. The recommended rock-filled timber crib dam would prevent virtually all of these losses.

5. <u>Annual Losses.</u> Estimated recurring losses at various flood stages in the Cherryfield area were converted to average annual losses to provide a basis for determining annual benefits to be used in evaluating a local protection project. Stage-damage data were correlated with stage-loss and stage-frequency data to derive damage-frequency relationships for the various protection schemes studied. The damage-frequency curve has been plotted with damage as the ordinate and percent-chance-of-occurrence (the reciprocal of frequency) as the abscissa. The area under this damage-frequency curve,(see Plate No. 11 at the end of this report,)is a measure of the average annual loss. Due to the sparsity of hydraulic data for rare ice-jam floods, annual losses have been derived from those ice-jam floods having a frequency or more than once in one hundred years. Annual losses

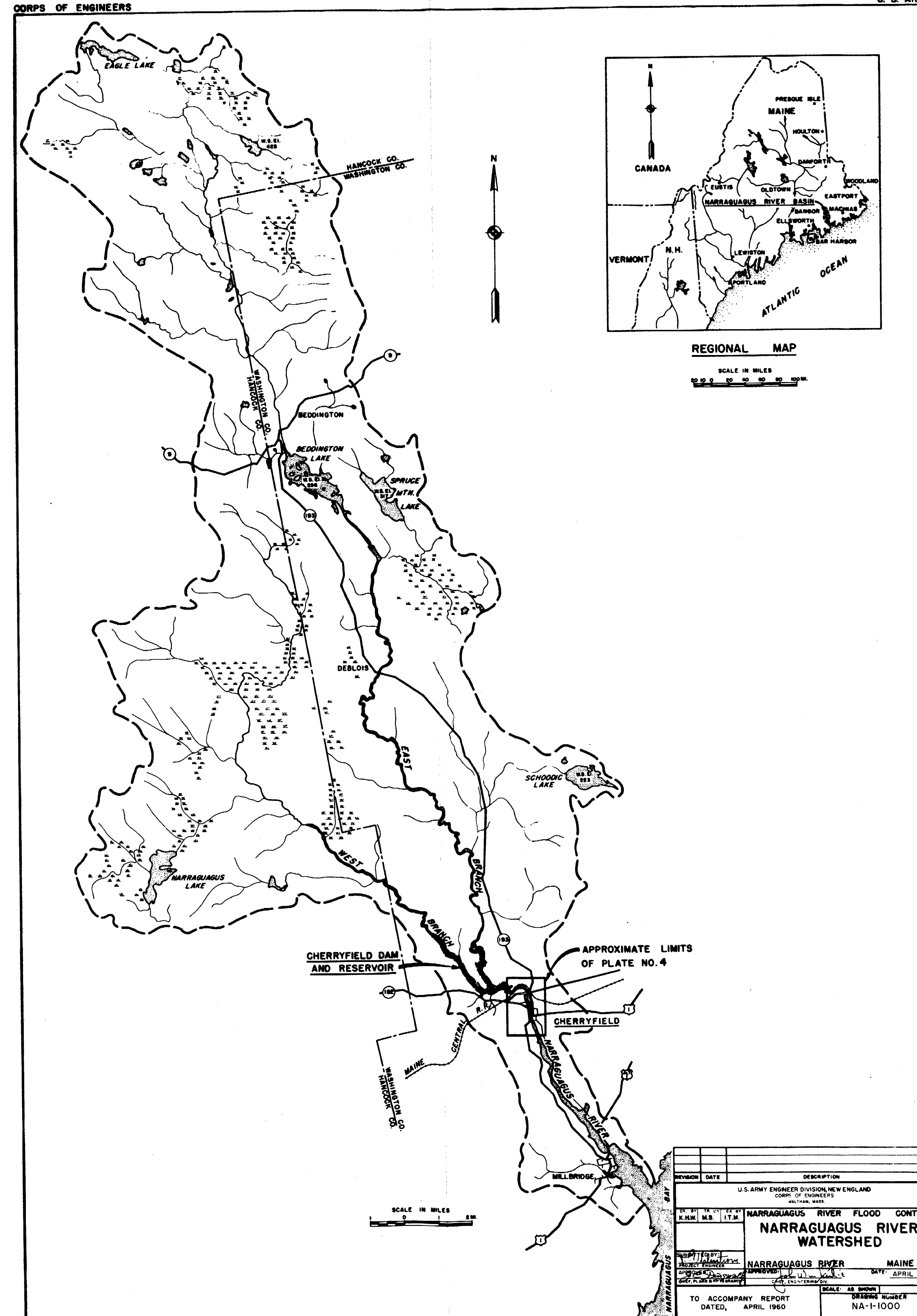
for the Cherryfield are estimated at $13,00 at 1960 price levels.

6. Flood Damage Prevention Benefits. Average annual flood damage prevention benefits accruing in the Cherryfield area represent the difference between average annual losses under present conditions and those losses remaining after construction of the local protection project. Annual losses resutling from ice-jam floods having a frequency greater than once every hundred years will be eliminated by the recommended project, thus developing annual benefits of $13,000.

7. Other Tangible Benefits. It is not anticipated that construction of the recommended project will substantially change the economic development of the community. In the past few years there has been no appreciable development in the available flood-free areas on the outskirts of the village. Only six structural changes have occurred within the flood area in recent years. A new blacksmith shop has been constructed on the east bank a short distance downstream from the Route 1 bridge. Two stores have been razed and three stores have been renovated in the central business district. In view of the spotty development within the community over a considerable number of years, no benefits are anticipated from the enhancement of land values in the flood area. Construction of the project would relieve the threat of ice-jam floods approximately every second year and encourage existing commercial establishments to remain in the central business district.

There are no indications that recreational benefits would accrue to the project. Incorporation of a fishway in the project design will permit continuation of Atlantic salmon runs that have reestablished and increased in the Narraguagus River since the destruction of three dams in Cherryfield during the 1942 flood. Most anglers who visit the Cherryfield area generally return home on the same day. No significant increase in recreational spending is anticipated in the Cherryfield area.

8. Intangible Benefits. In addition to tangible flood damage prevention benefits, significant intangible benefits would be realized from stage reductions effected by the project. Construction of the project would greatly lessen the flood threat to life and the potential danger of disease arising from the pollution of some 40 water supply wells located within the flood area. Insecurity and worry by the residents concerning unpredictable ice-jam flooding would be substantially reduced.



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NARRAGUAGUS RIVER FLOOD CONTROL

NARRAGUAGUS RIVER WATERSHED

NARRAGUAGUS RIVER MAINE

DATE: APRIL 1960

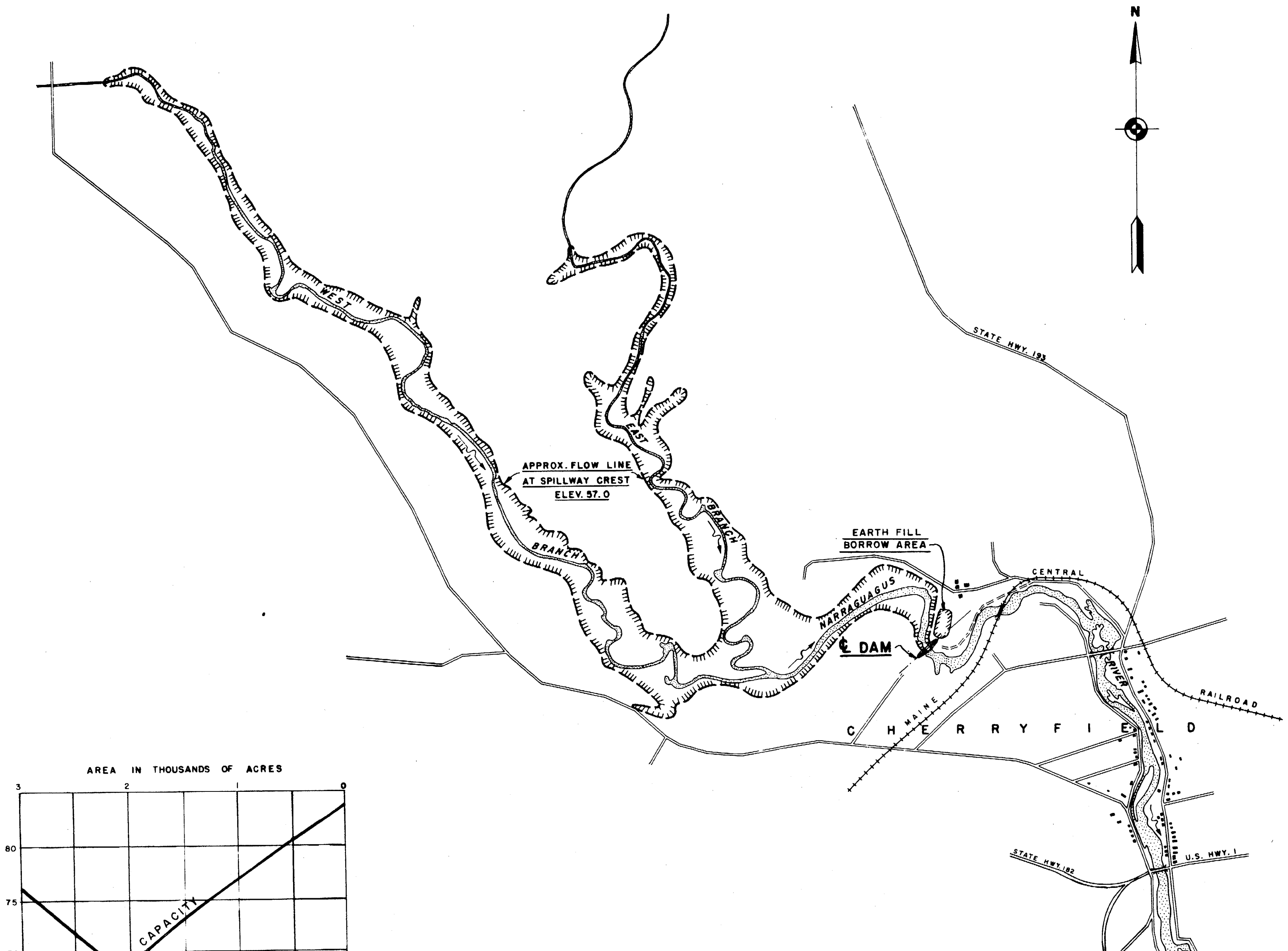
SCALE: AS SHOWN

DRAWING NUMBER NA-1-1000

TO ACCOMPANY REPORT DATED, APRIL 1960

CORPS OF ENGINEERS

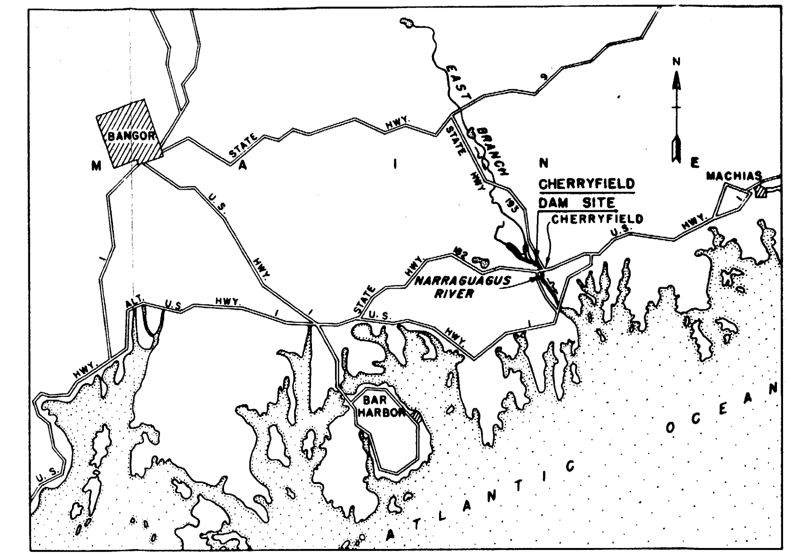
U. S. ARMY



RESERVOIR MAP

SCALE = 1:10,000

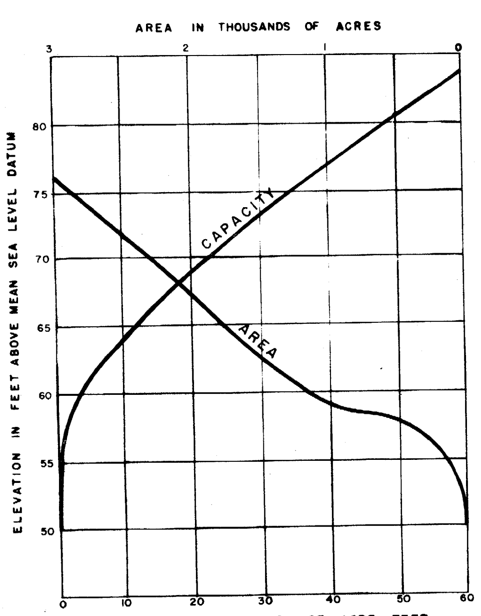
1000' 0 1000' 2000'



VICINITY MAP

SCALE IN MILES

5 0 5 15 25



AREA - CAPACITY CURVES

REVISION	DATE	DESCRIPTION	BY

U.S ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES BY I.T.M. W.A.S. | DR BY | CK BY

NARRAGUAGUS RIVER FLOOD CONTROL

CHERRYFIELD DAM

RESERVOIR MAP

NARRAGUAGUS RIVER MAINE

SUBMITTED BY: PROJECT ENGINEER

APPROVED: CHIEF, PLANN'G BR. & ENGINEERING DIV.

APPROVED: CHIEF, ENGINEERING DIV.

DATE: APRIL 1960

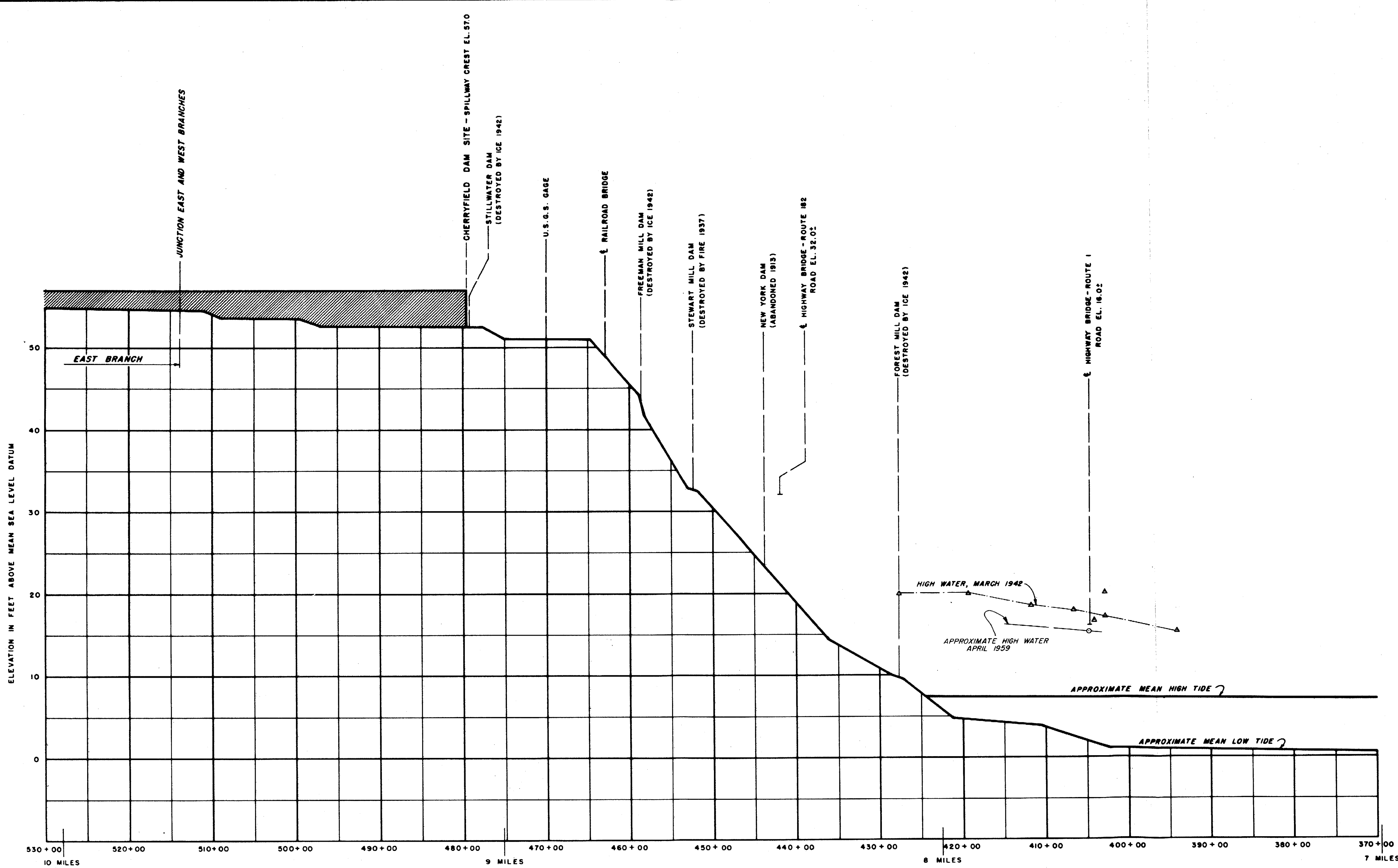
SCALE: AS SHOWN

TO ACCOMPANY REPORT
DATED, APRIL 1960

DRAWING NUMBER
NA-I-1001

PLATE NO. 2

CORPS OF ENGINEERS U. S. ARMY



LEGEND

- △ HIGH WATER MARK OF MARCH 1942
- RESERVOIR AT SPILLWAY CREST

NOTES

ELEVATION IN FEET ABOVE MEAN SEA LEVEL DATUM.

STATIONING IN FEET ABOVE ENTRANCE TO DREDGED CHANNEL IN NARRAGUAGUS BAY.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
W.A.S.	B.G.	I.T.M.

NARRAGUAGUS RIVER FLOOD CONTROL

PROFILE

NARRAGUAGUS RIVER

CHERRYFIELD MAINE

SUBMITTED BY: [signature] PROJECT ENGINEER

APPROVAL RECOMMENDED: [signature] CHIEF, PLANN. & RPTS BRANCH

APPROVED: [signature] CHIEF, ENGINEERING DIVISION

DATE: APRIL 1960

SCALE AS SHOWN

TO ACCOMPANY REPORT DATED, APRIL 1960

DRAWING NUMBER NA-1-1002

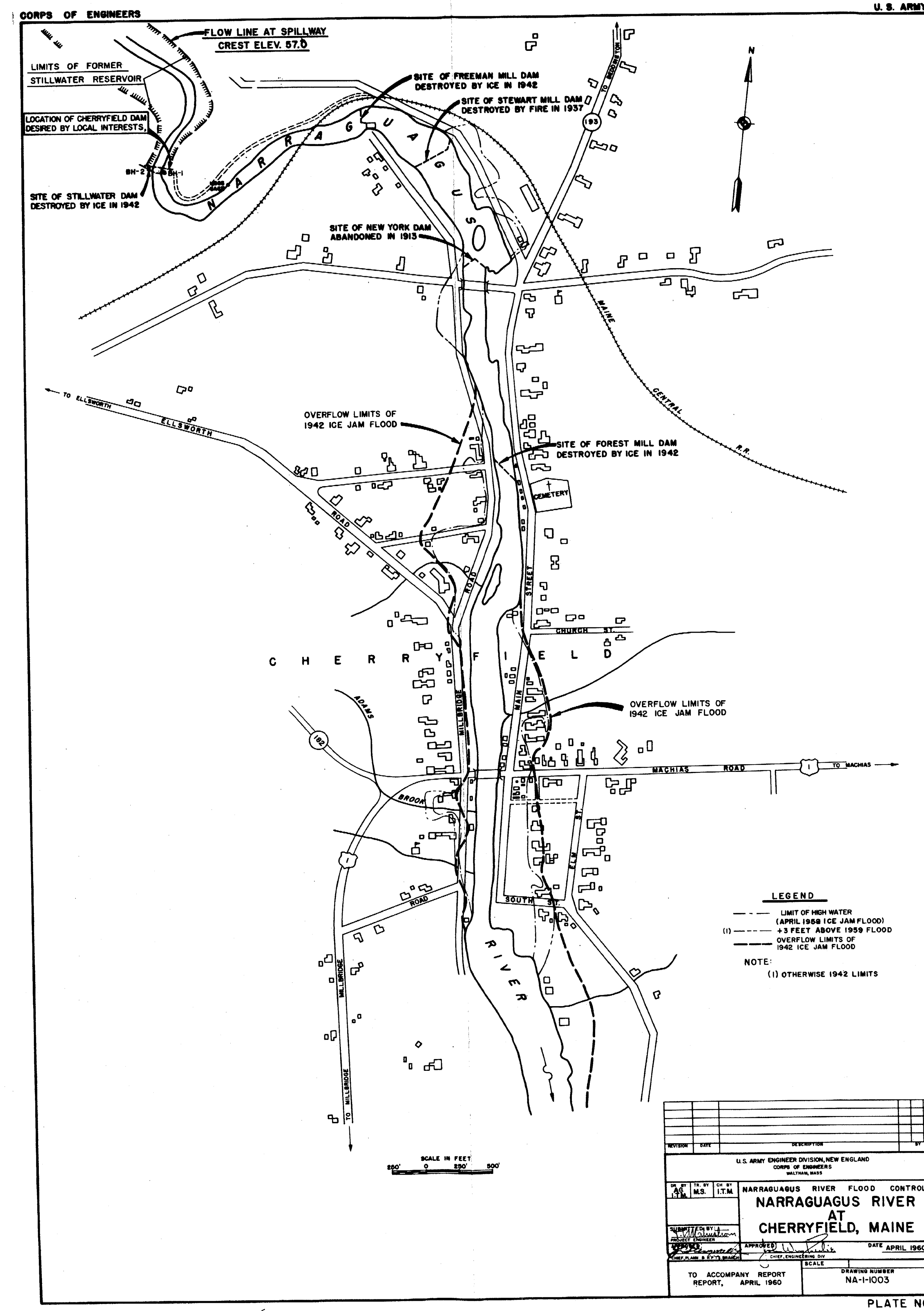
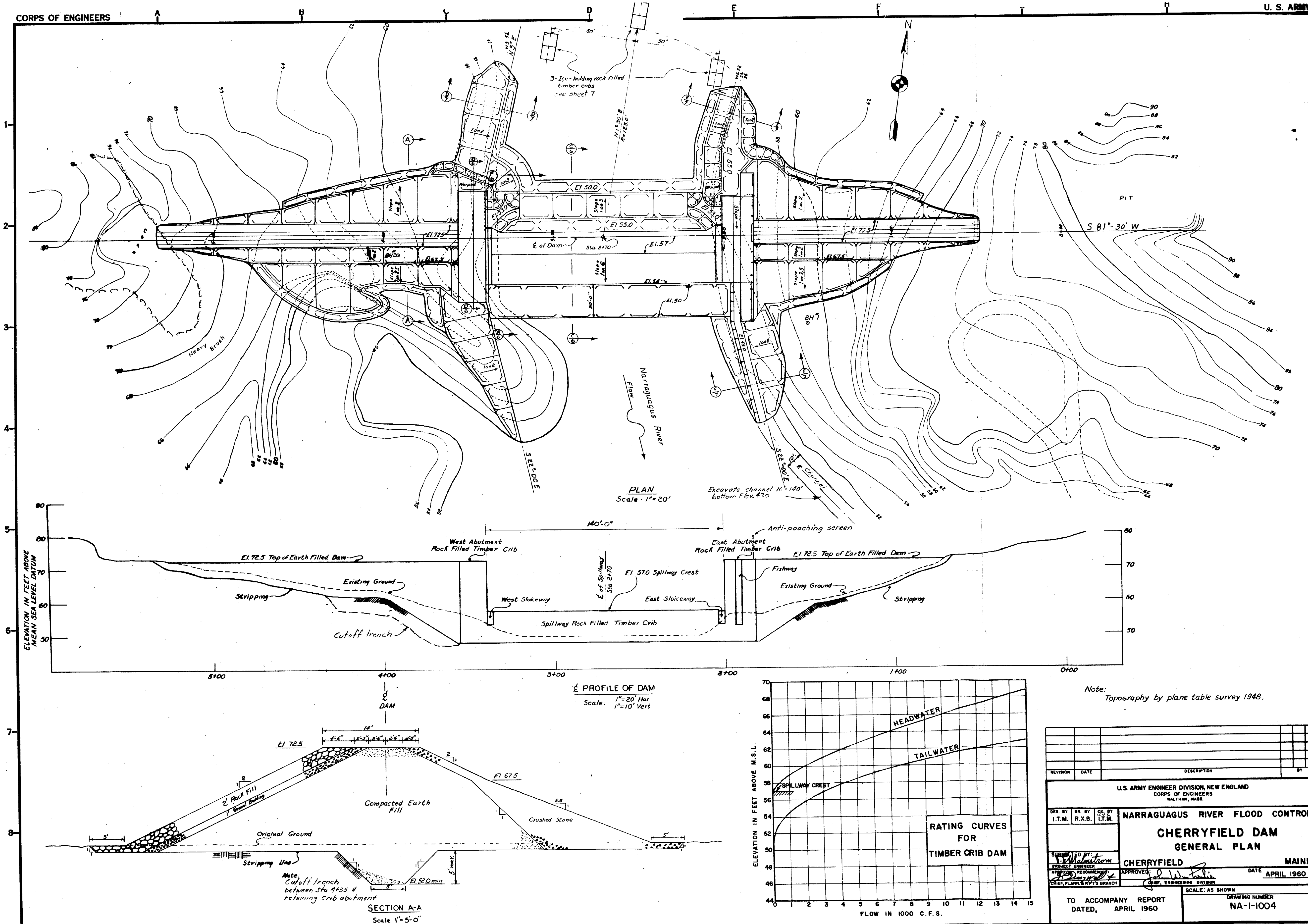

FLOW LINE AT SPILLWAY CREST ELEV. 57.0
LIMITS OF FORMER STILLWATER RESERVOIR
LOCATION OF CHERRYFIELD DAM DESIRED BY LOCAL INTERESTS.
BH-2
BH-1
SITE OF STILLWATER DAM DESTROYED BY ICE IN 1942
SITE OF FREEMAN MILL DAM DESTROYED BY ICE IN 1942
SITE OF STEWART MILL DAM DESTROYED BY FIRE IN 1937
SITE OF NEW YORK DAM ABANDONED IN 1913
N A R R A G U A G U S
TO BEDDINGTON
193
N
MAINE CENTRAL R.R.
TO ELLSWORTH
ELLSWORTH
ROAD
OVERFLOW LIMITS OF 1942 ICE JAM FLOOD
SITE OF FOREST MILL DAM DESTROYED BY ICE IN 1942
CEMETERY
MAIN STREET
CHURCH ST.
C H E R R Y F I E L D
ADAMS
MILLBRIDGE ROAD
OVERFLOW LIMITS OF 1942 ICE JAM FLOOD
MACHIAS ROAD
TO MACHIAS
1
182
BROOK
ELM
SOUTH ST.
ROAD
RIVER
TO MILLBRIDGE
LEGEND
LIMIT OF HIGH WATER (APRIL 1959 ICE JAM FLOOD)
(1) +3 FEET ABOVE 1959 FLOOD
OVERFLOW LIMITS OF 1942 ICE JAM FLOOD
NOTE:
(1) OTHERWISE 1942 LIMITS
SCALE IN FEET
250' 0 250' 500'
REVISION DATE DESCRIPTION BY
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS
DR. BY AG. I.T.M.
TR. BY M.S.
CH. BY I.T.M.
NARRAGUAGUS RIVER FLOOD CONTROL
NARRAGUAGUS RIVER AT CHERRYFIELD, MAINE
SUBMITTED BY: PROJECT ENGINEER
APPROVED: CHIEF, PLANN. & R'P'TS. BRANCH
APPROVED: CHIEF, ENGINEERING DIV
DATE APRIL 1960
SCALE
TO ACCOMPANY REPORT REPORT, APRIL 1960
DRAWING NUMBER
NA-1-1003

PLATE NO. 4



REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY I.T.M. | DR. BY R.X.B. | CK. BY I.T.M.

NARRAGUAGUS RIVER FLOOD CONTROL

CHERRYFIELD DAM

GENERAL PLAN

CHERRYFIELD MAINE

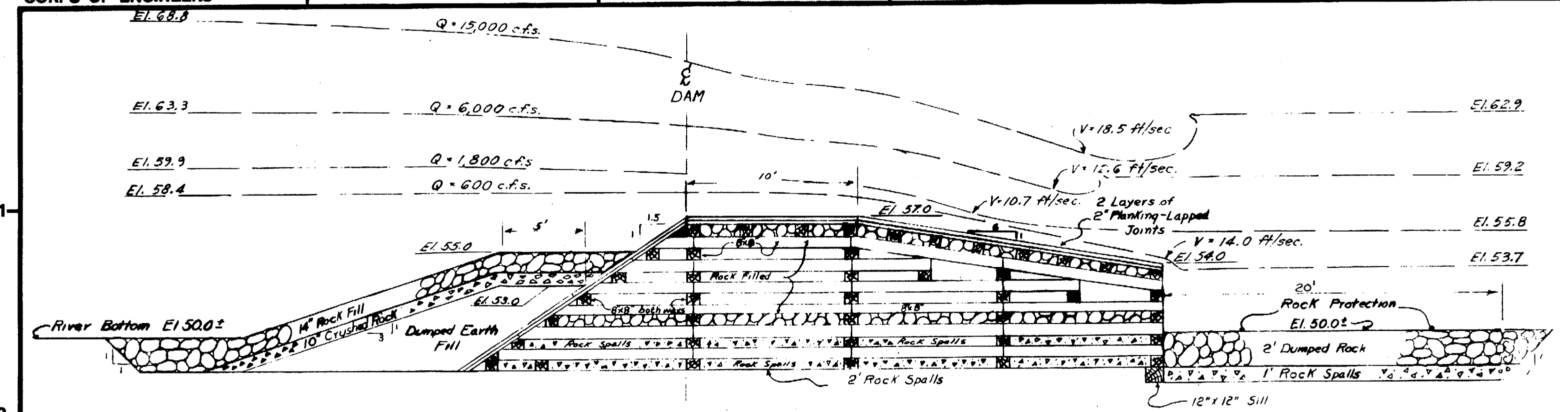
SUBMITTED BY: PROJECT ENGINEER
APPROVAL RECOMMENDED: CHIEF, PLANN'G & RPT'S BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE APRIL 1960
SCALE: AS SHOWN

TO ACCOMPANY REPORT DATED, APRIL 1960

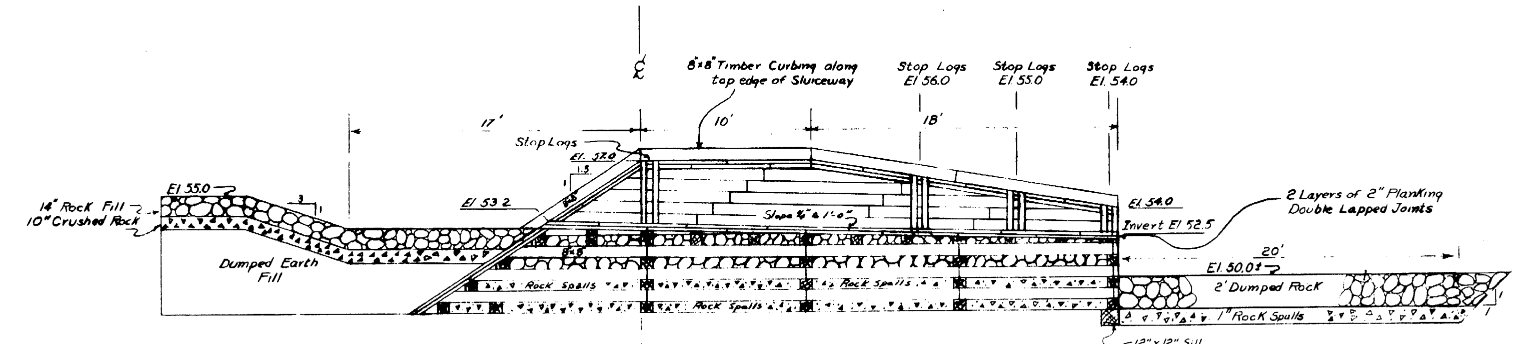
DRAWING NUMBER NA-1-1004

PLATE NO. 5

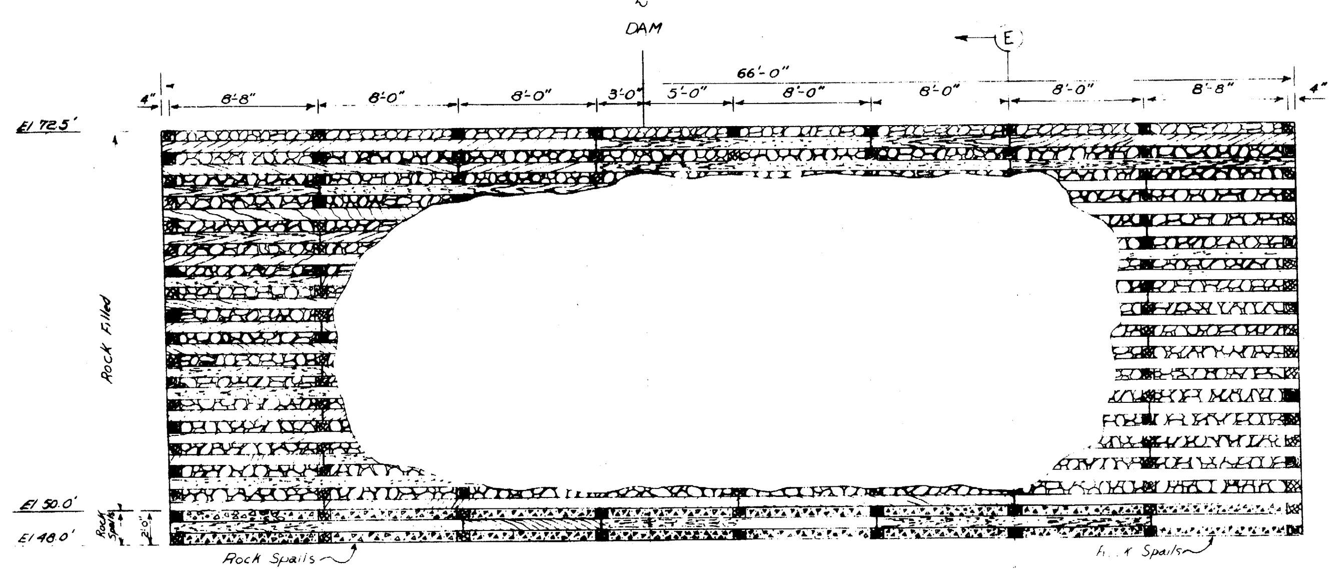
CORPS OF ENGINEERS — U. S. ARMY



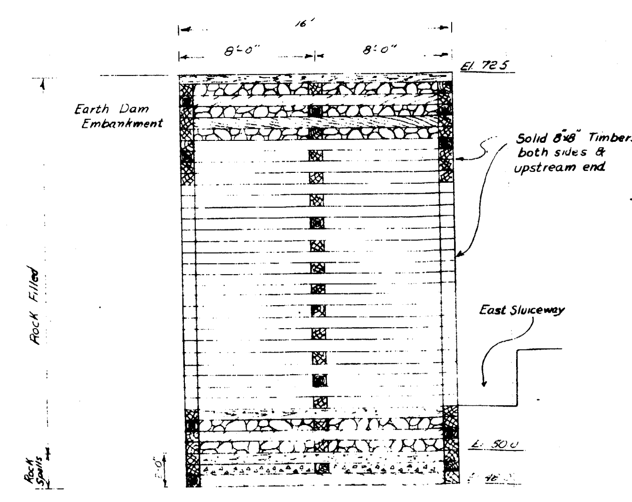
SPILLWAY
SECTION C-C
5



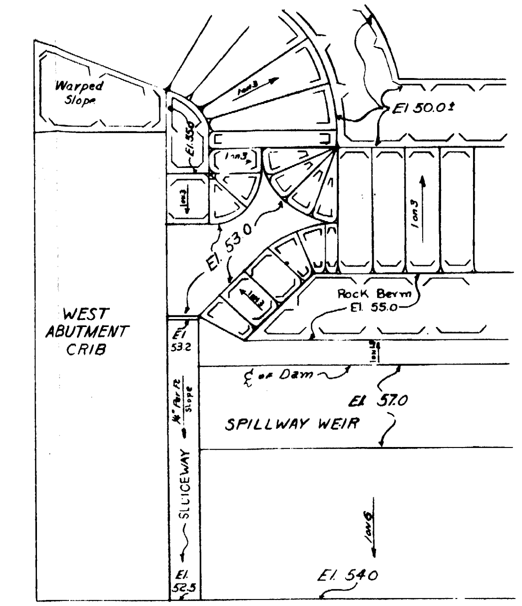
WEST SLUICEWAY
SECTION F-F
5



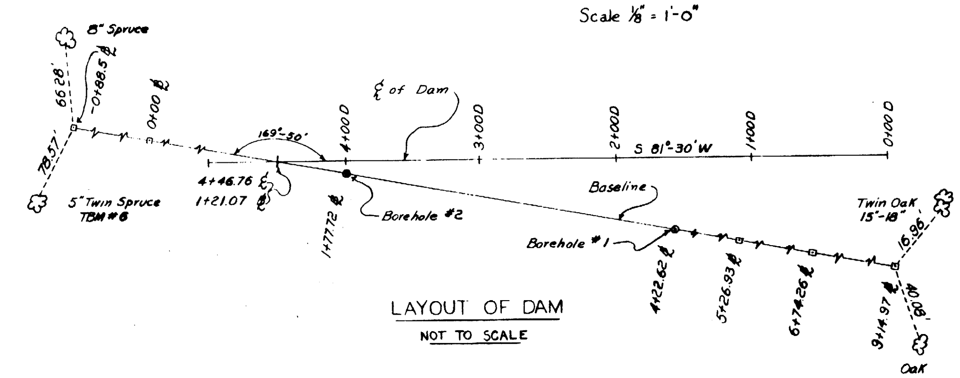
WEST ABUTMENT CRIB
SECTION D-D
5



SECTION E-E



PLAN - WEST SLUICEWAY
East Sluiceway opposite hand
Scale 1/8" = 1'-0"



LAYOUT OF DAM
NOT TO SCALE

NOTE
Tie each intersection of 8"x8" timbers with 2-5/8"x15" drift bolts.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.F.C. I.T.M. — DR. BY R.X.B. — CK. BY I.T.M. J.J.C.

NARRAGUAGUS RIVER FLOOD CONTROL
CHERRYFIELD DAM
WEST ABUTMENT
SPILLWAY & SLUICEWAY SECTIONS
CHERRYFIELD — MAINE

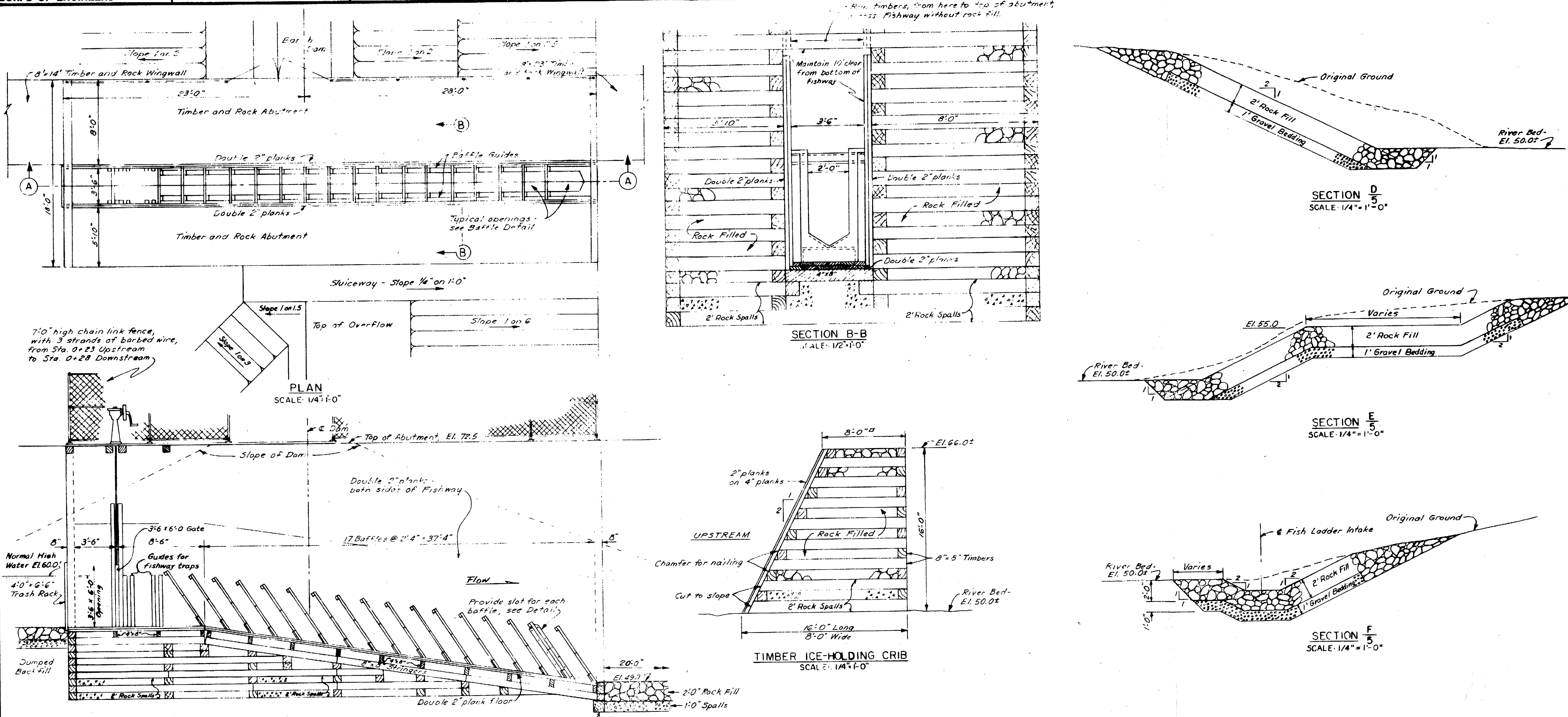
SUBMITTED BY: PROJECT ENGINEER
RECOMMENDED: CHIEF, PLANN'G & R.P.T'S BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
DATE: APRIL 1960
SCALE 1/8" = 1'-0"

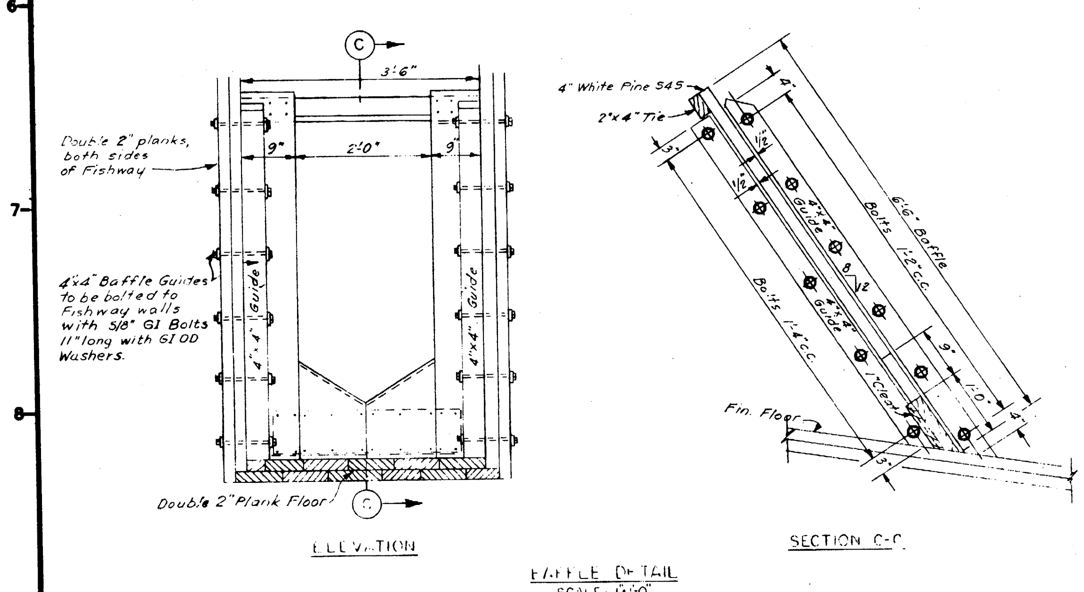
TO ACCOMPANY REPORT DATED, APRIL 1960

DRAWING NUMBER NA-1-1005

PLATE NO. 6

CORPS OF ENGINEERS U. S. ARMY





NOTES

All lumber to be creosoted with the exception of the fishway planking, baffles, guides and gates which are to be untreated timber.

Entire Fishway at El. 72.5 to be protected with chain link anti-poaching screen.

Lapped joints on all double planking.

Wingwalls to have 8"x8" solid timber sides and upstream ends.

Tie each intersection of 8"x8" timbers with 2-5/8"x15" drift bolts.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY J.F.C. I.T.M. | DR. BY K.H.W. | CK. BY J.J.C. I.T.M.

NARRAGUAGUS RIVER FLOOD CONTROL

CHERRYFIELD DAM

FISH LADDER & EAST ABUTMENT

CHERRYFIELD MAINE

SUBMITTED BY: [signature] PROJECT ENGINEER

APPROVAL RECOMMENDED: [signature] CHIEF, PLANN. & RPT'S BRANCH

APPROVED: [signature] CHIEF, ENGINEERING DIVISION

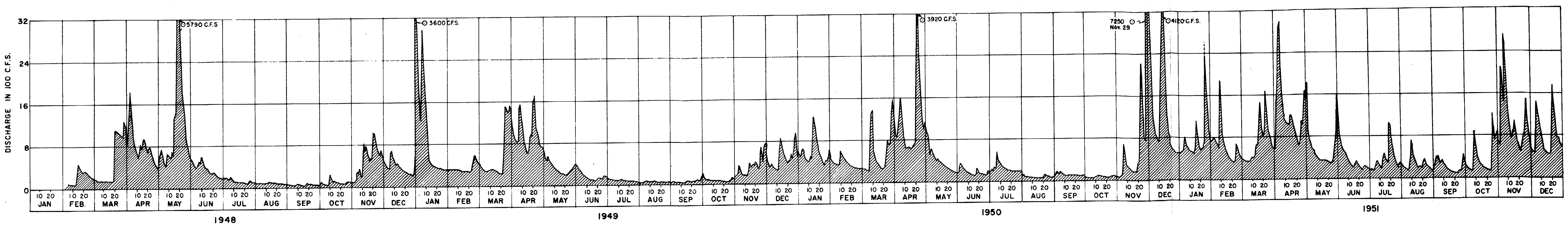
DATE APRIL 1960

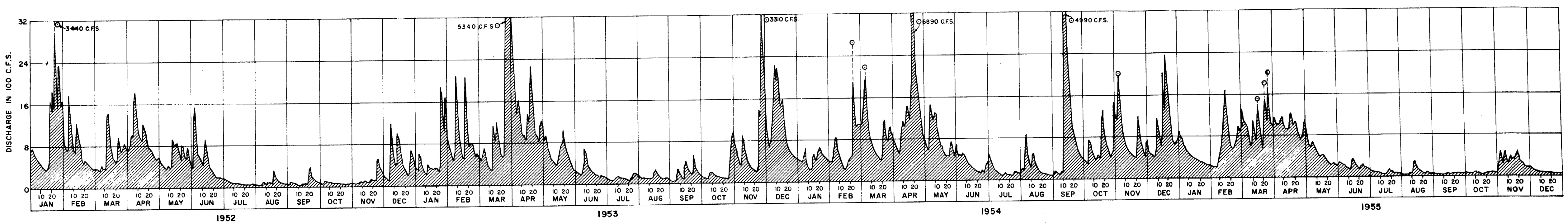
SCALE: AS SHOWN

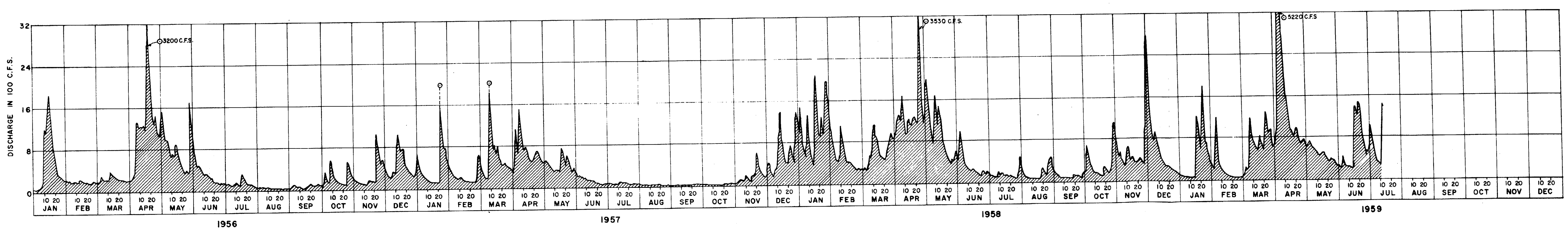
TO ACCOMPANY REPORT DATED, APRIL 1960

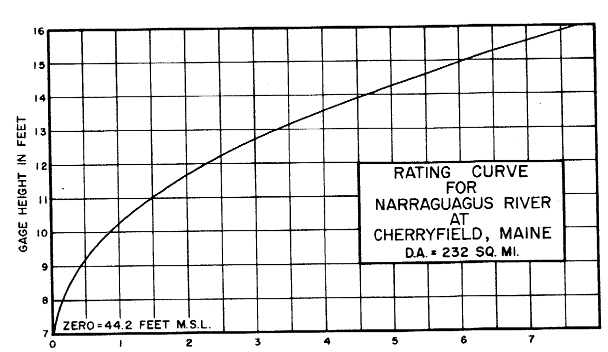
DRAWING NUMBER NA-1-1006

PLATE NO. 7









NOTES

These hydrographs are the daily average stream flow record of Narraguagus River at the U.S.G.S. gage at Cherryfield, Maine from the drainage area of 232 square miles.

Instantaneous peak discharges where available are shown by ⊙.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DR. BY | TR. BY M.W.B. | CK. BY N.L.

NARRAGUAGUS RIVER FLOOD CONTROL

NARRAGUAGUS RIVER HYDROGRAPHS

NARRAGUAGUS RIVER — MAINE

E. F. Chiles
CHIEF, HYD. & HYD. SECT.

SUBMITTED BY: T. Malmstrom
PROJECT ENGINEER

APPROVED:
CHIEF, PLANN & R'P'TS BRANCH

APPROVED:
CHIEF, ENGINEERING DIV.

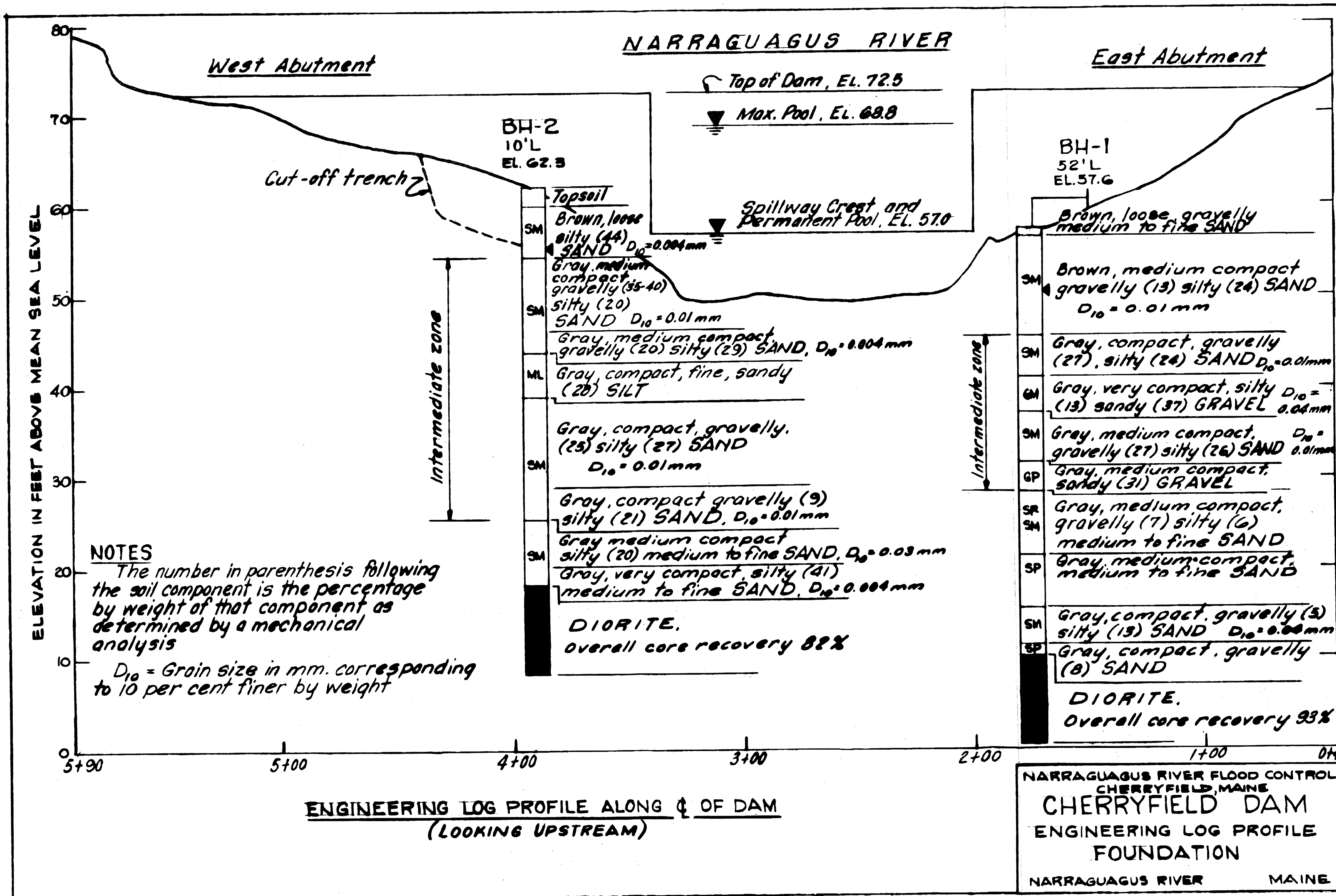
DATE APRIL 1960

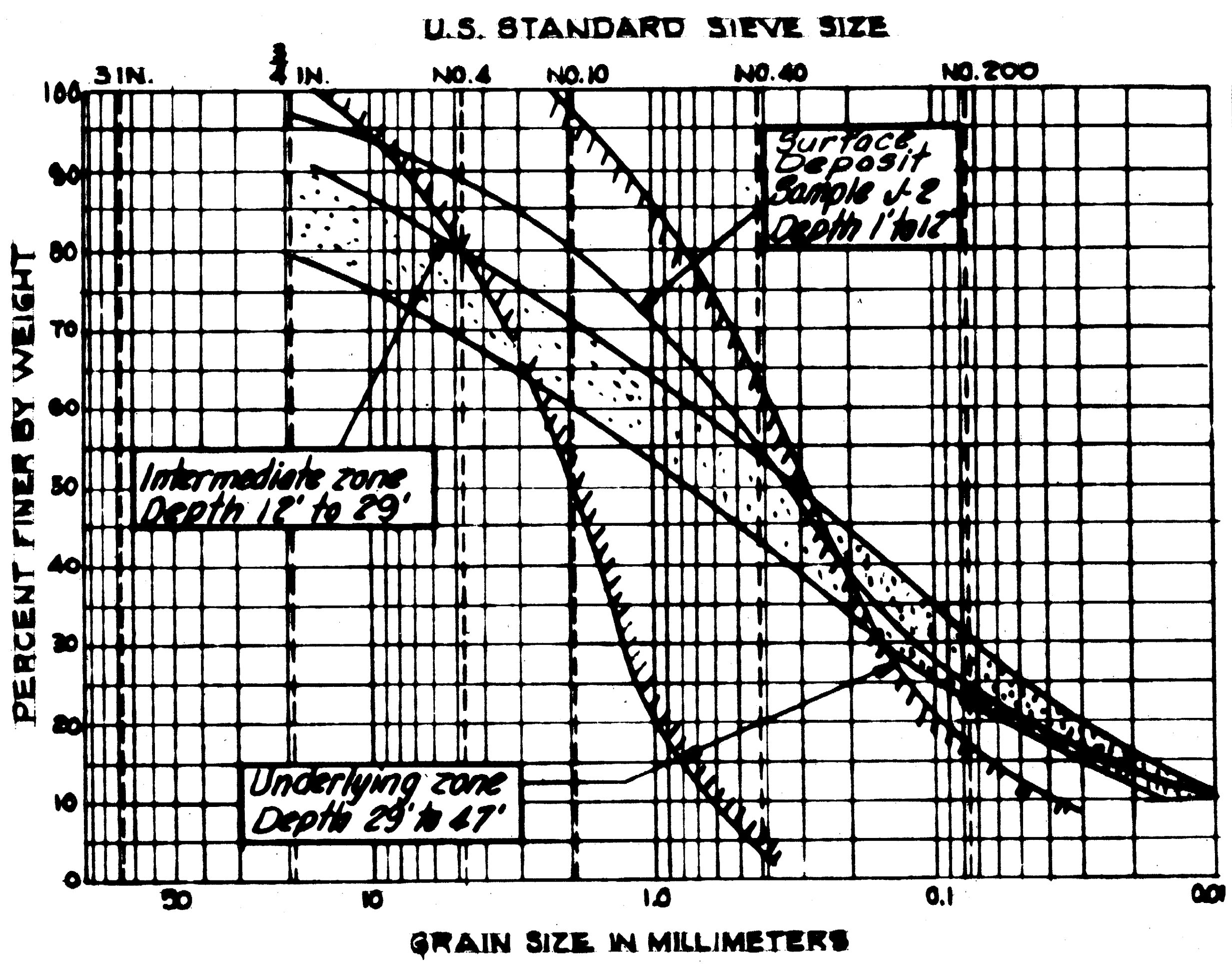
SCALE

TO ACCOMPANY REPORT DATED, APRIL 1960

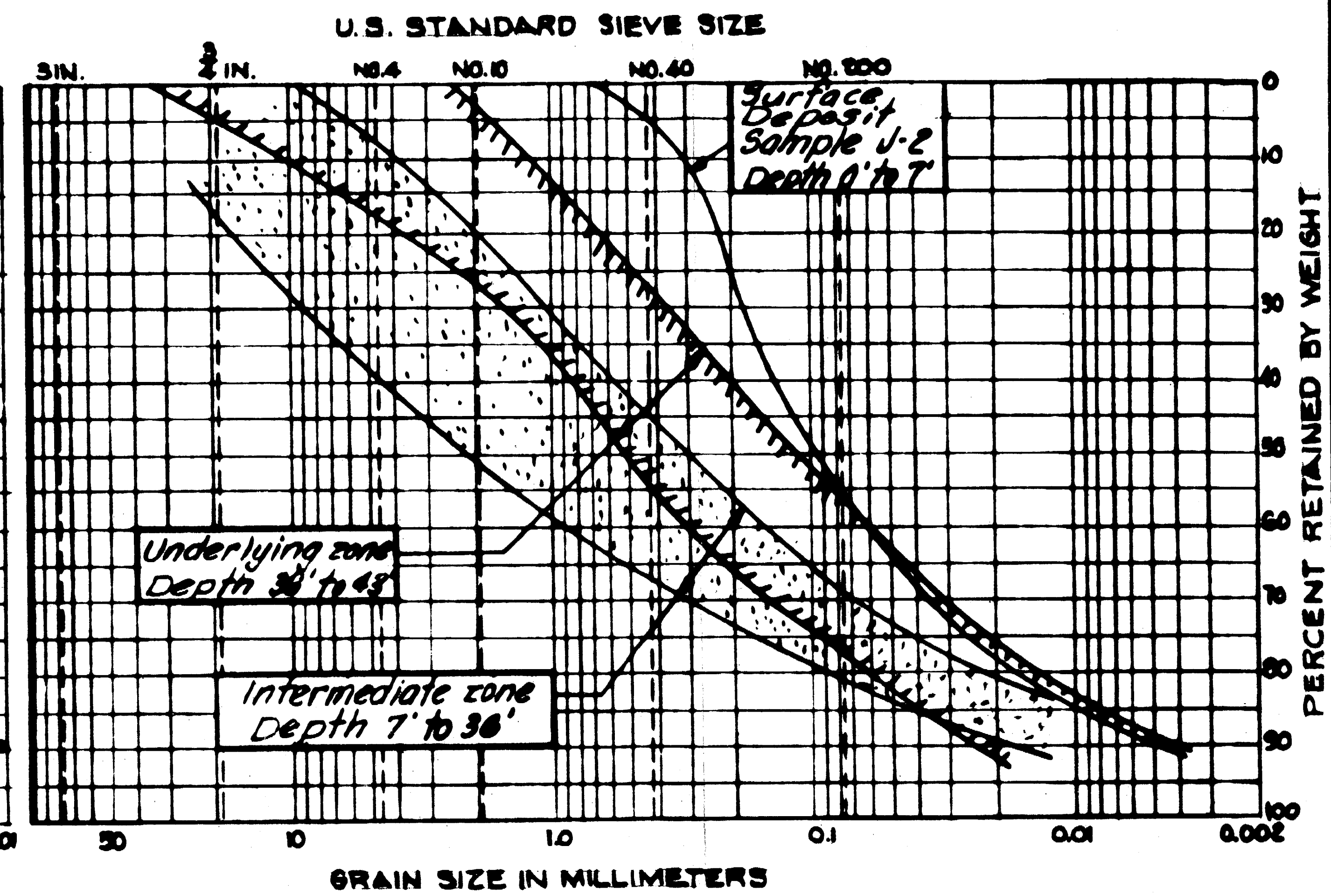
DRAWING NUMBER NA-1-1007

PLATE NO. 8


NARRAGUAGUS RIVER
West Abutment
East Abutment
Top of Dam, EL. 72.5
Max. Pool, EL. 68.8
Spillway Crest and Permanent Pool, EL. 57.0
BH-2
10'L
EL. 62.3
BH-1
52'L
EL. 57.6
Cut-off trench
Intermediate zone
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
Topsoil
Brown, loose silty (44) SAND D_{10}=0.004 mm
Gray, medium compact gravelly (35-40) silty (20) SAND D_{10}=0.01 mm
Gray, medium compact gravelly (20) silty (29) SAND, D_{10}=0.004 mm
Gray, compact, fine, sandy (20) SILT
Gray, compact, gravelly (25) silty (27) SAND D_{10}=0.01 mm
Gray, compact gravelly (9) silty (21) SAND, D_{10}=0.01 mm
Gray medium compact silty (20) medium to fine SAND, D_{10}=0.03 mm
Gray, very compact, silty (41) medium to fine SAND, D_{10}=0.004 mm
DIORITE. Overall core recovery 82%
Brown, loose, gravelly medium to fine SAND
Brown, medium compact gravelly (13) silty (24) SAND D_{10}=0.01 mm
Gray, compact, gravelly (27), silty (24) SAND D_{10}=0.01 mm
Gray, very compact, silty (13) sandy (37) GRAVEL D_{10}=0.04 mm
Gray, medium compact, gravelly (27) silty (26) SAND D_{10}=0.01 mm
Gray, medium compact, sandy (31) GRAVEL
Gray, medium compact, gravelly (7) silty (6) medium to fine SAND
Gray, medium compact, medium to fine SAND
Gray, compact, gravelly (5) silty (13) SAND D_{10}=0.04 mm
Gray, compact, gravelly (8) SAND
DIORITE. Overall core recovery 93%
SM
ML
GM
GP
SP
SP SM
0
10
20
30
40
50
60
70
80
5+90
5+00
4+00
3+00
2+00
1+00
0+43
NOTES
The number in parenthesis following the soil component is the percentage by weight of that component as determined by a mechanical analysis
D_{10} = Grain size in mm. corresponding to 10 per cent finer by weight
ENGINEERING LOG PROFILE ALONG ℄ OF DAM
(LOOKING UPSTREAM)
NARRAGUAGUS RIVER FLOOD CONTROL
CHERRYFIELD, MAINE
CHERRYFIELD DAM
ENGINEERING LOG PROFILE
FOUNDATION
NARRAGUAGUS RIVER MAINE



BORING BH-1
EAST ABUTMENT



BORING BH-2
WEST ABUTMENT

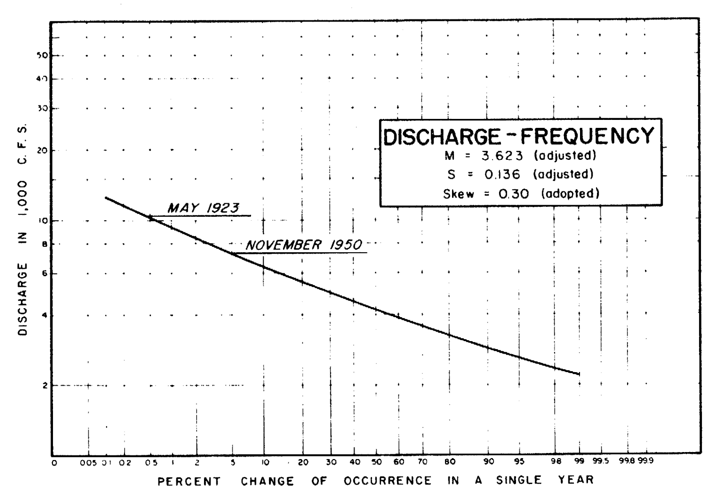
NARRAGUAGUS RIVER FLOOD CONTROL
CHERRYFIELD, MAINE

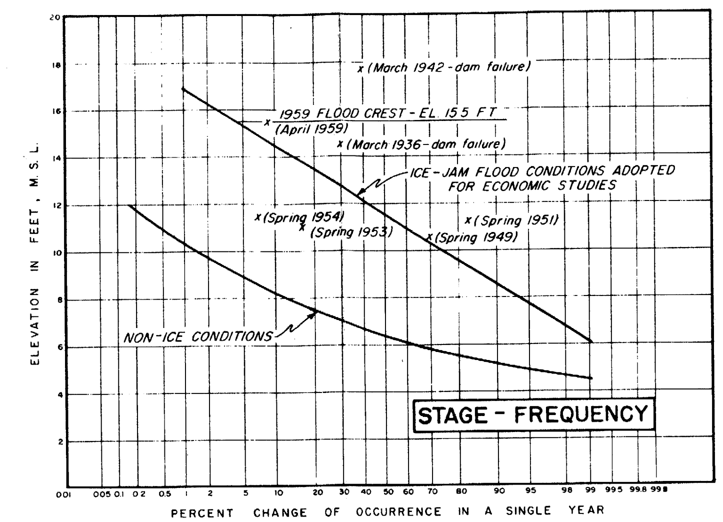
CHERRYFIELD DAM

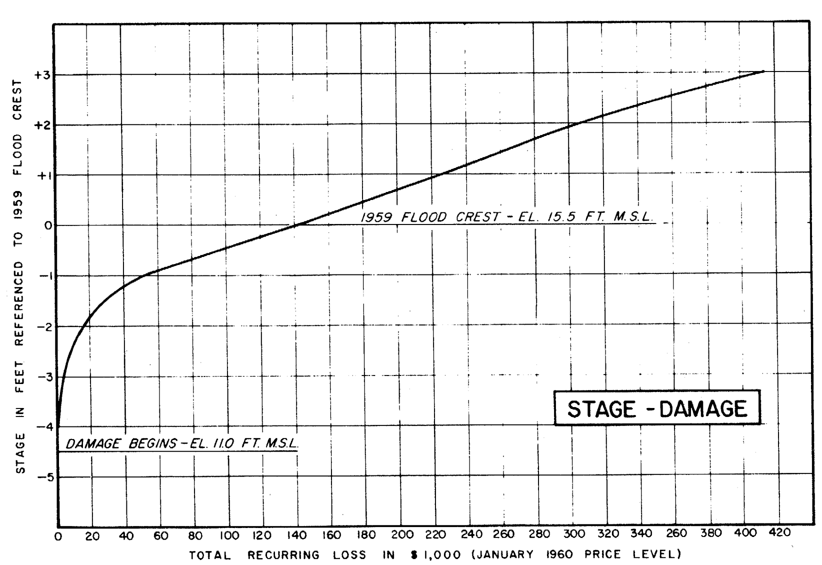
GRAIN SIZE DISTRIBUTION
OF FOUNDATION SOIL

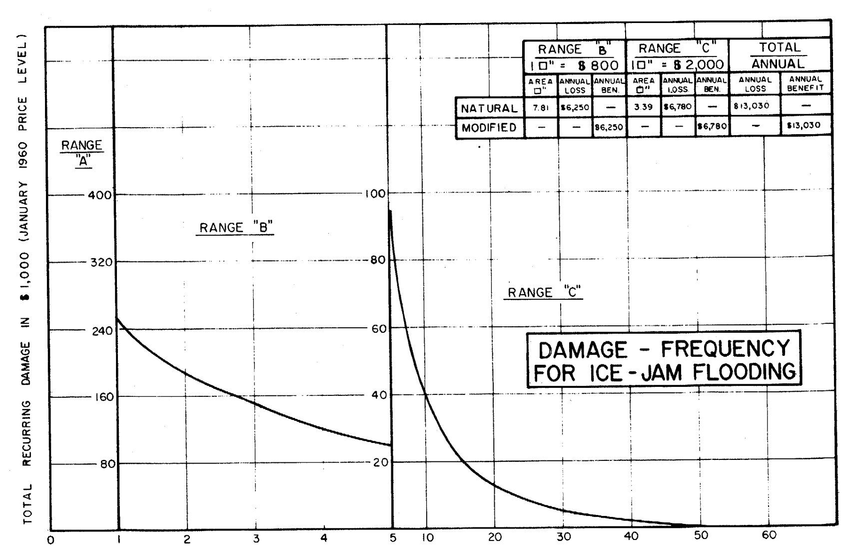
NARRAGUAGUS RIVER MAINE

PLATE NO. 10









	RANGE "B" 1□" = $800			RANGE "C" 1□" = $2,000			TOTAL ANNUAL	
	AREA □"	ANNUAL LOSS	ANNUAL BEN.	AREA □"	ANNUAL LOSS	ANNUAL BEN.	ANNUAL LOSS	ANNUAL BENEFIT
NATURAL	7.81	$6,250	—	3.39	$6,780	—	$13,030	—
MODIFIED	—	—	$6,250	—	—	$6,780	—	$13,030

NARRAGUAGUS RIVER FLOOD CONTROL

CURVES FOR ECONOMIC ANALYSIS

INDEX STATION: U. S. ROUTE ONE BRIDGE
CHERRYFIELD, MAINE
U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

SUBJECT Cherry Field Dam
COMPUTATION Abutments + Spillway Stability
COMPUTED BY GFH CHECKED BY ______ DATE 26 Feb. '60

Assumptions

Dike Soil

sat. wt. = 125 pcf
subm. wt. = 62.5 pcf
ϕ = 30°
lat. pr. k = 0.5
tan ϕ = 0.577

Crib Materials

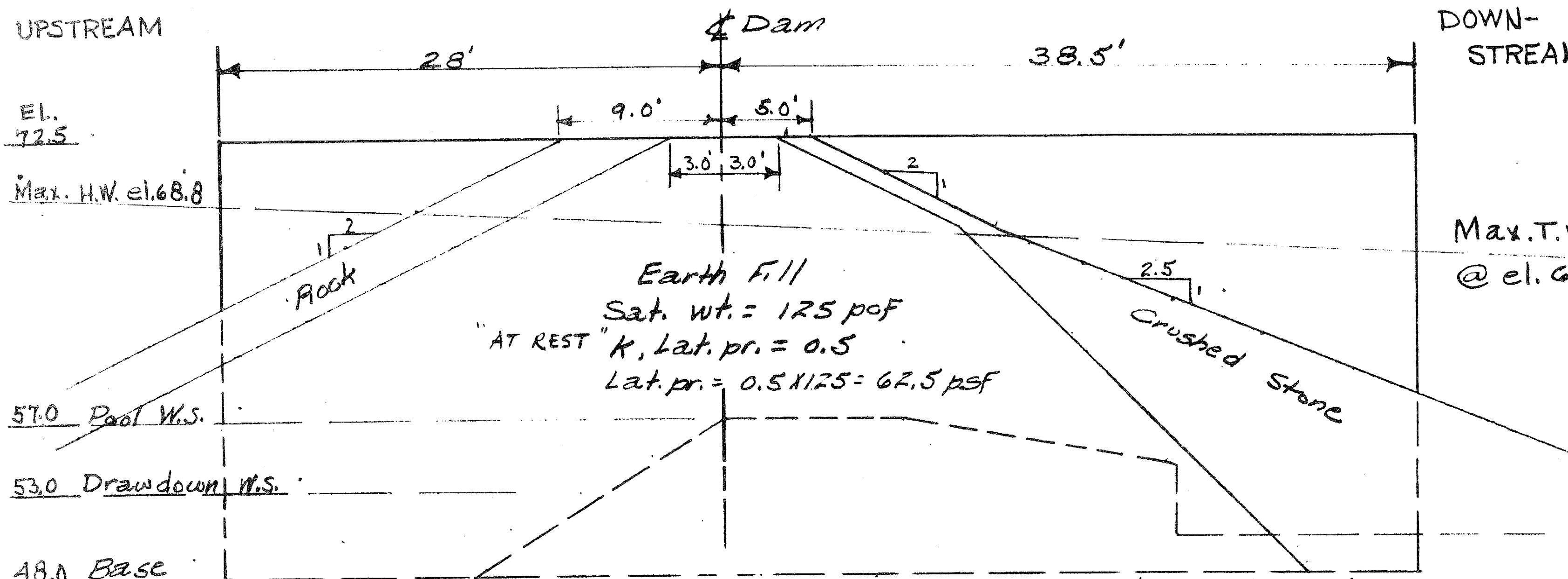
	Rock	Timber
sat. wt.	111 pcf	
subm. wt.	70 pcf	−12.5 pcf
	34% voids	

For design purposes assume Dike soil to be uniform.

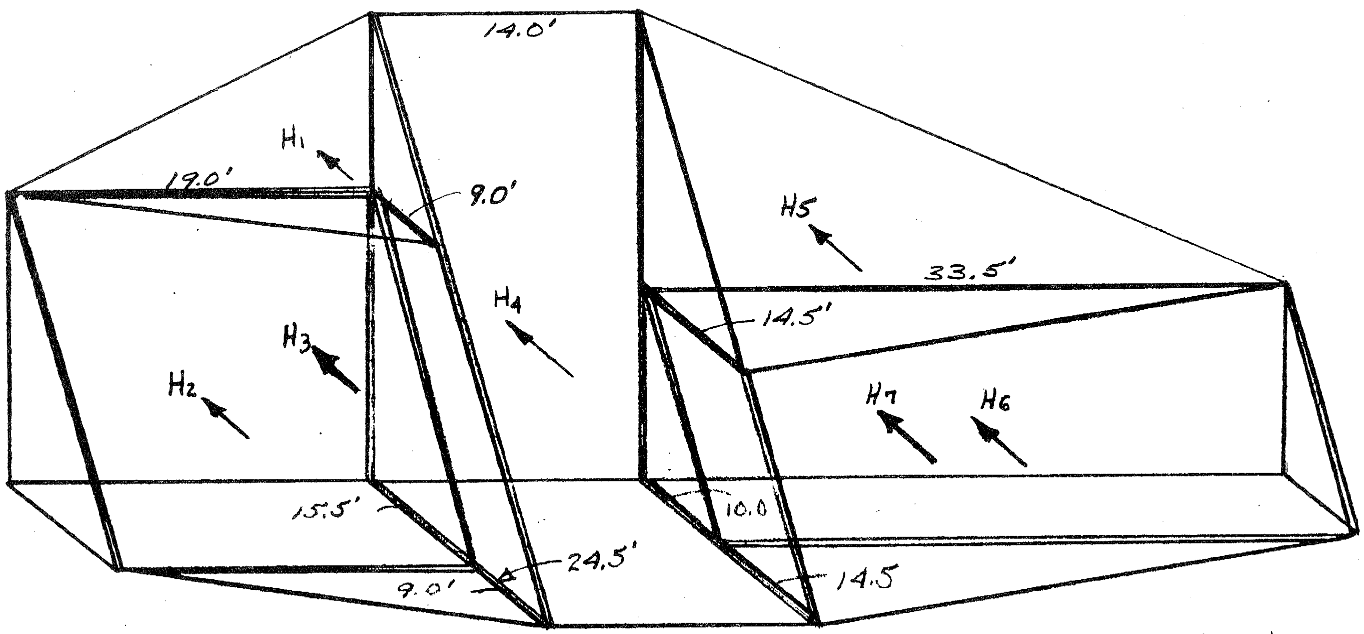
The outlines of the lateral soil pressure diagrams are based on scalar dimensions and are not exact but are conservative.

For stability the timbers + rock comprising the cribs act monolithically.

SUBJECT Cherry Field Dam
COMPUTATION West Abutment - Stability Cont
COMPUTED BY SFH CHECKED BY DATE 18 Feb 1966



Section Thru Dike Looking East at West Abutment

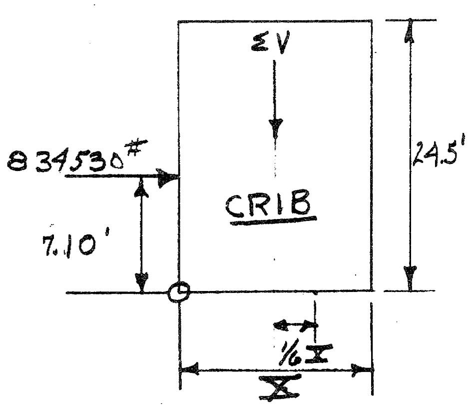


Lateral Pressure Diagram - Earth fill dimen. are approx.

SUBJECT Cherry Field Dam
COMPUTATION West Abutment - Stability - Case I
COMPUTED BY GFH CHECKED BY DATE 18 Feb. 1960

Unit	Factors	Force ← lb	Arm Ft	Moment
H_1	62.5 x 9.0 x 9.0 x 19.0 x 1/6	16,030	17.75	284,500
H_2	62.5 x 15.5 x 15.5 x 19.0 x 1/2	142,800	5.17	738,000
H_3	62.5 x 9.0 x 19.0 x 15.5 x 1/2	82,800	7.75	642,000
H_4	62.5 x 24.5 x 24.5 x 14.0 x 1/2	263,000	8.17	2,150,000
H_5	62.5 x 14.5 x 14.5 x 33.5 x 1/6	73,300	13.62	998,000
H_6	62.5 x 10.0 x 10.0 x 33.5 x 1/2	104,800	3.33	348,500
H_7	62.5 x 14.5 x 10.0 x 33.5 x 1/2	151,800	5.0	759,000
		834,530 ΣH	7.10'	5,920,000 ΣM

Case I:
Rapid drawdown;
Sat. soil in Crib;
Sat. soil in Dike.



Assume average density of crib+soil inside = 111 pcf.

$\Sigma V = 111 \times 24.5 \times 66.5\,X = 181{,}000\,X$

ΣM @ $\frac{1}{6}X = 0$ For max. stability

$5{,}920{,}000 = (181{,}000\,X)\left(\frac{X}{6}\right)$

" $= 30{,}166\,X^2$

$X = \sqrt{196.5} = 14.0'$ min. Use 16'

$\frac{\Sigma H}{\Sigma V} = \frac{834{,}500}{181{,}000 \times 13.5} = 0.341$

Crib to be built in two rows of 8'x8' cells.

Design of flexural members of crib:
8"x8" timbers - Norway Pine - Com. Struct.: F = 1100 psi $v = 75$ psi
@ 16" o.c. see Ketchum's "Struct. Eng. Handbook" p.403

max. lateral pres. $= \frac{wR}{\mu'}$ $w = 111$ pcf $R = \frac{64}{32} = 2.0$ $\mu' = 0.50$

$= \frac{111 \times 2.0}{0.50} = 444$ psf say 500 psf

$V = 500 \times 4.0 \times \frac{16}{12} = 2{,}666^{\#}$ $v = \frac{3}{2} \times \frac{2666}{56.3} = 71$ psi < 75 psi ∴ O.K.

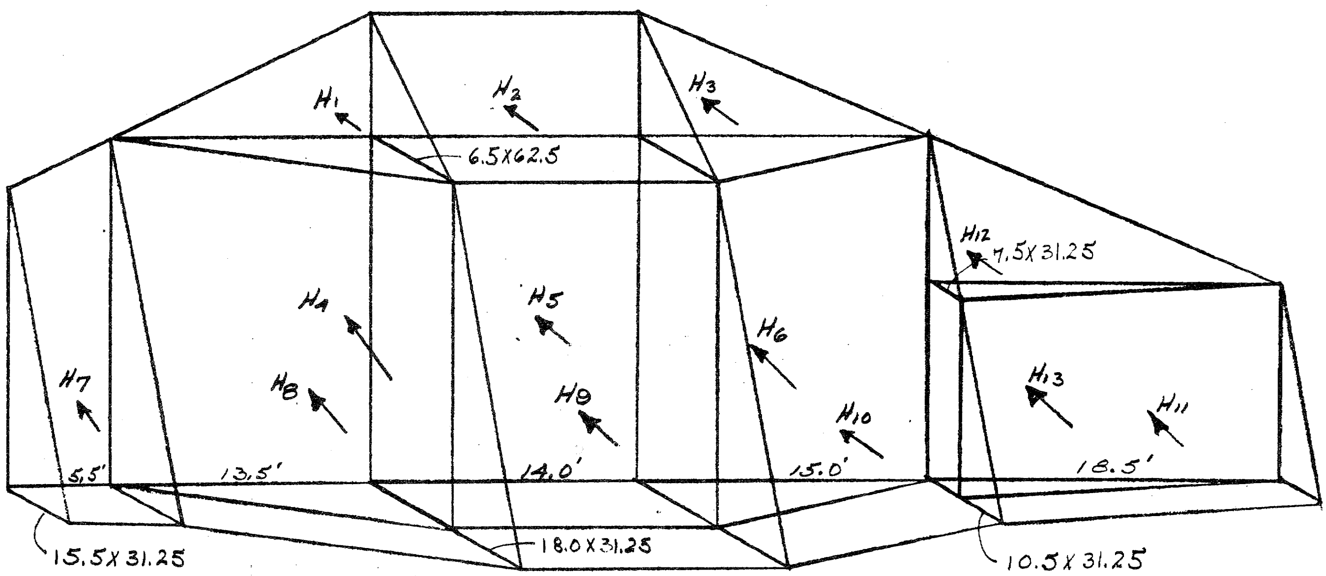
$F = \frac{1 \times 500 \times 8^2 \times 12 \times 16}{8 \times 70.3 \times 12} = 910$ psi < 1100 psi ∴ O.K.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Cherry Field Dam
COMPUTATION West Abutment - Stability - Case II
COMPUTED BY G.F.H. CHECKED BY DATE 23 Feb. 1960

Case II: Maximum flood flow; assume ave. water @ el. 66.0
Use submerged wt. below + sat. wt. above.

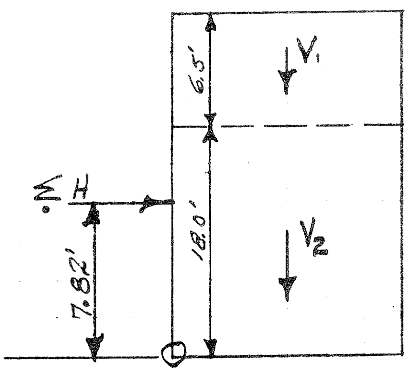


Lateral Soil Pressure Diagram (hydrostatic pr's balance on both sides)

Unit	Factors	Force ← lbs.	Arm Ft	Moment ↻
H1	62.5X6.5X6.5X13.5 x 1/6	5940	19.6	116200
H2	62.5X6.5X6.5X14.0 x 1/2	18500	20.2	373500
H3	62.5 x 6.5 x6.5 X 15.0 x 1/6	6600	19.6	129400
H4	62.5 x 6.5 X 18.0X 13.5X 1/2	49400	9.0	444600
H5	62.5X6.5 X 14.0X 18.0	102300	9.0	920700
H6	62.5X6.5X 18.0 x 15.0 X 1/2	54900	9.0	494100
H7	31.25 x 16.75 x 16.75 x 5.5 x 1/2	24100	5.58	134500
H8	31.25 X 18.0 X 18.0 X 13.5 x 1/2	68400	6.0	410400
H9	31.25 X 18.0X 18.0 X 14.0 X 1/2	70900	6.0	425400
H10	31.25 x 18.0 x 18.0 x 15.0 x 1/2	76000	6.0	456000
H11	31.25 x 10.5 X 10.5X 18.5X 1/2	31900	3.5	111800
H12	31.25 x 7.5 x 7.5 X 18.5 X 1/6	5410	12.4	67100
H13	31.25 x 7.5X 10.5X 18.5 X 1/2	22800	5.25	119000
		537,150 ΣH	7.82	4,202,700 ΣM_H

SUBJECT Cherry Field Dam
COMPUTATION West Abutment - Stability - Case II
COMPUTED BY SFH CHECKED BY DATE 25 Feb. '60

Sat. wt. of rock in crib = 111 pcf.
Subm. " " " " " = 70 pcf



$\Sigma V_1 = (16 \times 6.5 \times 66.5)(111) = 768{,}000^{\#}$

When crib is submerged:

85% of volume = rock @ 70 pcf ↓
15% " " = timber @ 12.5 " ↑

$V_2 = 16.0 \times 18.0 \times 66.5 = 19{,}150$ C.F.

$\Sigma V_2 = (0.85 \times 19{,}150 \times 70) - (0.15 \times 19{,}150 \times 12.5)$

$= 1{,}140{,}000 - 35{,}900 = 1{,}104{,}100^{\#}$

$\Sigma V = \Sigma V_1 + \Sigma V_2 = 1{,}872{,}000^{\#}$

$\Sigma M_A = 4{,}202{,}700 + (\overset{14{,}976{,}000}{1{,}872{,}000 \times 8}) = 19{,}178{,}700$

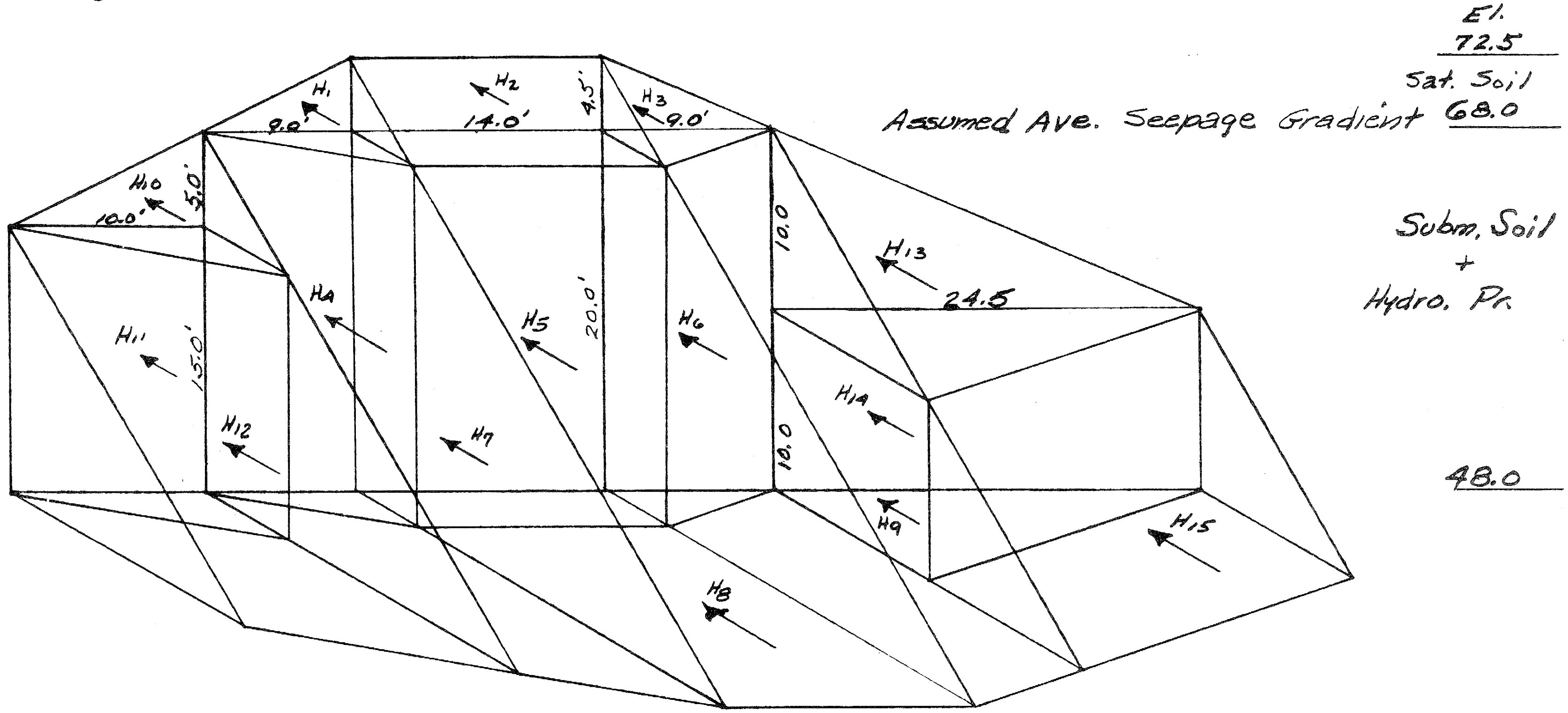
$\frac{\Sigma M_A}{\Sigma V} = \frac{19{,}178{,}700}{1{,}872{,}000} = 10.24'$ within mid 1/3 by 0.43' O.K.

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

NED FORM 223
27 Sept 49

SUBJECT Cherry Field Dam
COMPUTATION Abutment Stability - West
COMPUTED BY GFH CHECKED BY DATE 6 July 1960

Case III: Rapid drawdown after flood with maximum seepage gradient in dike @ el. 68.0. Use saturated soil above + submerged soil below el. 68.0. Use active soil pressure, $k_a = 1/3$.



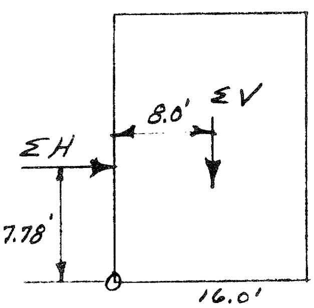
Sat. Wt. = 125 pcf   Sat. Lat. Pr. = 125 x 1/3 = 42 psf
Subm. Wt. = 62.5 pcf   Subm " " + water = 62.5 x 4/3 = 83.4 psf

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Cherry Field Dam
COMPUTATION Abutment Stability - West
COMPUTED BY GFH CHECKED BY DATE 6 July 1960

Unit	Factors	Force Pounds	Arm Ft.	Moment
H1	42.5 x 9.0 x 4.5 x 4.5 x 1/6	1290	21.125	27,250
H2	42.5 x 14.0 x 4.5 x 4.5 x 1/2	6020	21.5	129,400
H3	42.5 x 9.0 x 4.5 x 4.5 x 1/6	1290	21.125	27,250
H4	42.5 x 4.5 x 9.0 x 20.0 x 1/2	17200	10.0	172,000
H5	42.5 x 4.5 x 14.0 x 20.0	53500	10.0	535,000
H6	42.5 x 4.5 x 9.0 x 20.0 x 1/2	17200	10.0	172000
H7	83.4 x 20.0 x 20.0 x 9.0 x 1/2	150000	6.66	1000000
H8	83.4 x 20.0 x 20.0 x 14.0 x 1/2	235500	6.66	1556000
H9	83.4 x 20.0 x 20.0 x 9.0 x 1/2	150000	6.66	1000000
H10	83.4 x 5.0 x 5.0 x 10.0 x 1/6	3470	16.25	56500
H11	83.4 x 5.0 x 15.0 x 10.0 x 1/2	31250	7.5	234500
H12	83.4 x 15.0 x 15.0 x 10.0 x 1/2	93800	5.0	469000
H13	83.4 x 10.0 x 10.0 x 24.5 x 1/6	34100	12.5	426000
H14	83.4 x 10.0 x 10.0 x 24.5 x 1/2	10200	5.0	501000
H15	83.4 x 10.0 x 10.0 x 24.5 x 1/2	10200	3.33	34000
		815,020 ΣH		6,339,900 ΣM_H



$\Sigma V = 111 \times 16 \times 24.5 \times 66.5 = 2{,}900{,}000\#$

$\Sigma M = \overset{23{,}200{,}000}{(2{,}900{,}000 \times 8.0)} + 6{,}339{,}900$

$= 29{,}539{,}900$

$\bar{x} = \dfrac{29{,}539{,}900}{2{,}900{,}000} = 10.18'$ within mid 1/3

by 0.48'

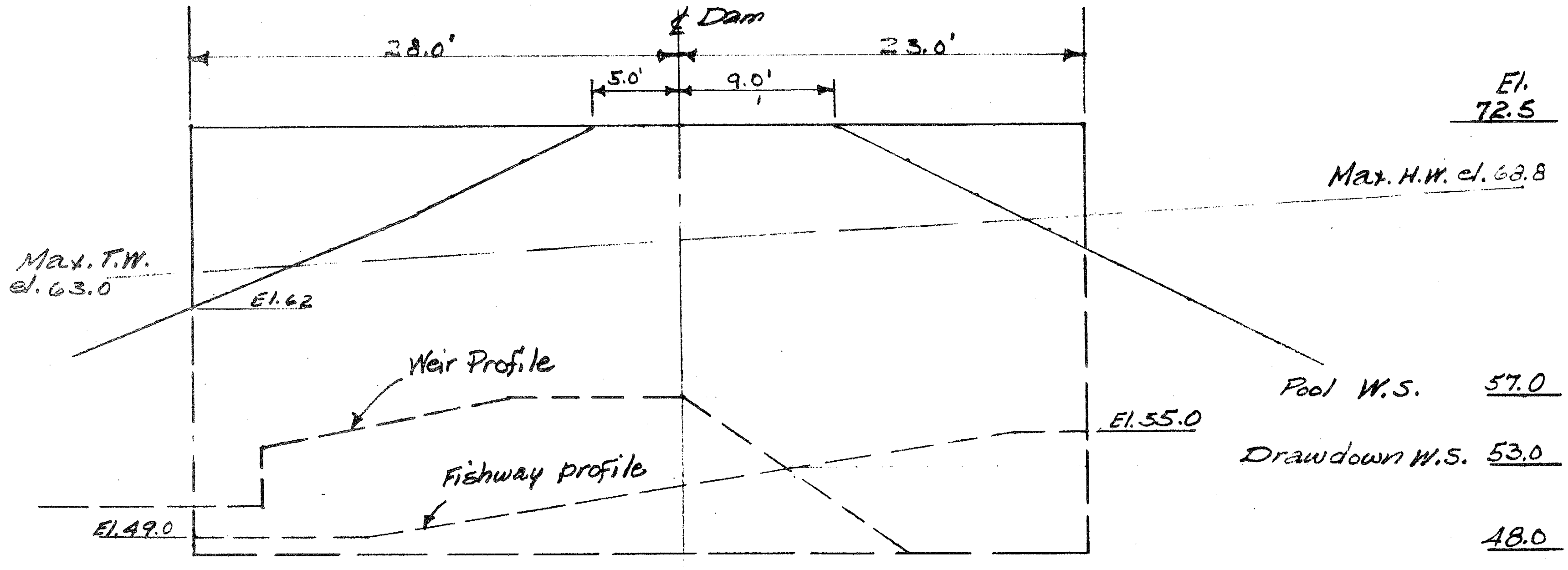
O.K.

NED FORM 223
27 Sept 49

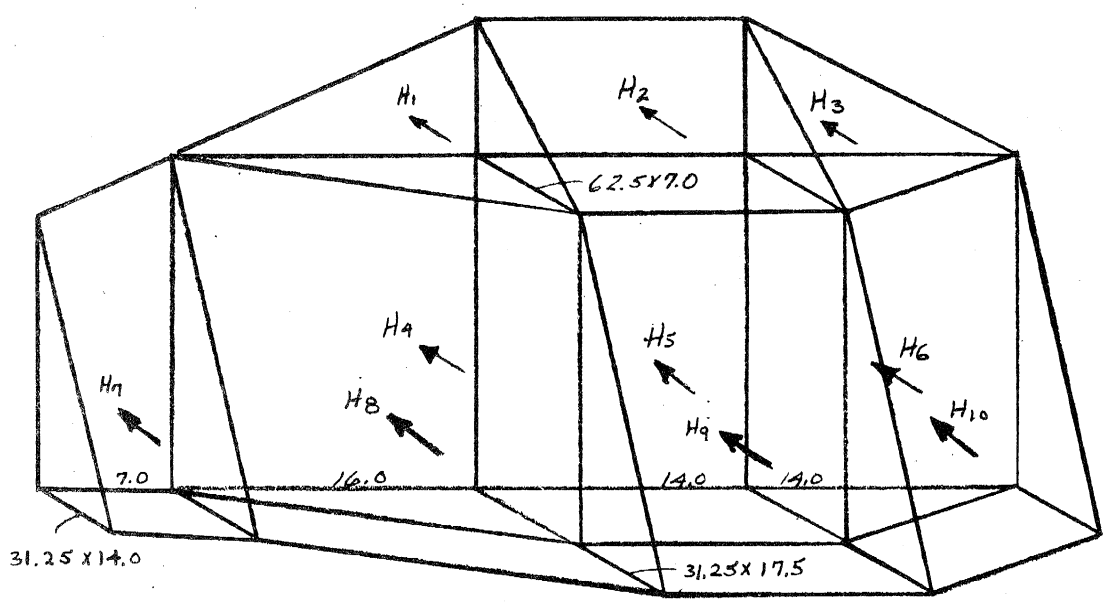
NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

PAGE 6

SUBJECT: Cherry Field Dam
COMPUTATION: East Abutment - Stability - Case II
COMPUTED BY: GFH
CHECKED BY:
DATE: 23 Feb. 1960

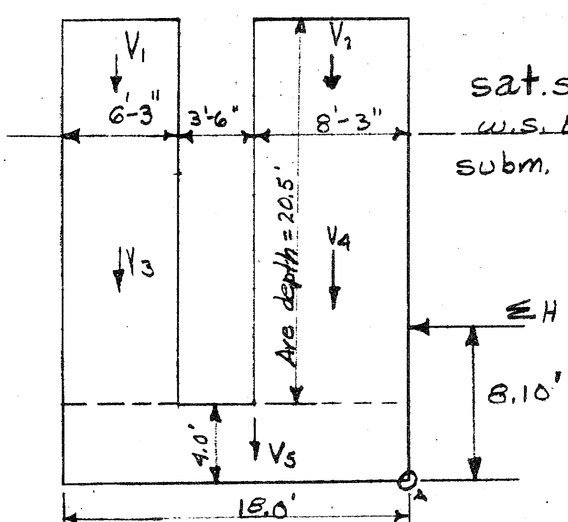


Section Thru Dike Looking West at East Abutment



SUBJECT Cherry Field Dam
COMPUTATION East Abutment - Stability - Case II
COMPUTED BY GFH CHECKED BY DATE 24 Feb. '60

Unit	Factors	Force ← lbs	Arm Ft	Moment ↻
H_1	62.5 × 7.0 × 7.0 × 16.0 × 1/6	8160	19.0	155000
H_2	62.5 × 7.0 × 7.0 × 14.0 × 1/2	21450	19.5	418500
H_3	62.5 × 7.0 × 7.0 × 14.0 × 1/6	7150	19.0	135700
H_4	62.5 × 7.0 × 17.5 × 16.0 × 1/2	61250	8.75	536000
H_5	62.5 × 7.0 × 17.5 × 14.0	107200	8.75	938000
H_6	62.5 × 7.0 × 17.5 × 14.0 × 1/2	53600	8.75	469000
H_7	31.25 × 15.75 × 15.75 × 7.0 × 1/2	27100	5.25	142400
H_8	31.25 × 17.5 × 17.5 × 16.0 × 1/2	76500	5.83	446000
H_9	31.25 × 17.5 × 17.5 × 14.0 × 1/2	67000	5.83	391000
H_{10}	31.25 × 17.5 × 17.5 × 14.6 × 1/2	67000	5.83	391000
		496,410 ΣH	8.10	4,022,600 ΣM



$\Sigma V_1 = 111 \times 6.25 \times 6.5 \times 51.0 = 230{,}000\#$

$\Sigma V_2 = 111 \times 8.25 \times 6.5 \times 51.0 = 303{,}000\#$

$V_3 = 14.0 \times 6.25 \times 51.0 = 4460$ C.F.

$\Sigma V_3 = (0.85 \times 4460 \times 70) - (0.15 \times 4460 \times 12.5)$
$= 266{,}000 - 8{,}400 = 257{,}600\#$

$V_4 = 14.0 \times 8.25 \times 51.0 = 5890$ C.F.

$\Sigma V_4 = (0.85 \times 5{,}890 \times 70) - (0.15 \times 5890 \times 12.5)$
$= 350{,}000 - 11{,}000 = 339{,}000\#$

$V_5 = 4.0 \times 18.0 \times 51.0 = 3670$ C.F.

$\Sigma V_5 = (0.85 \times 3670 \times 70) - (0.15 \times 3670 \times 12.5)$
$= 219{,}000 - 6{,}900 = 212{,}100\#$

$\Sigma V = 1{,}358{,}700$

$\Sigma M_A = 4{,}022{,}600 + (487{,}600 \times 14.88) + (642{,}000 \times 4.12) + (212{,}100 \times 9.0)$

$= 4{,}022{,}600 + 7{,}250{,}000 + 2{,}650{,}000 + 1{,}908{,}900$
$= 15{,}831{,}500\#'$

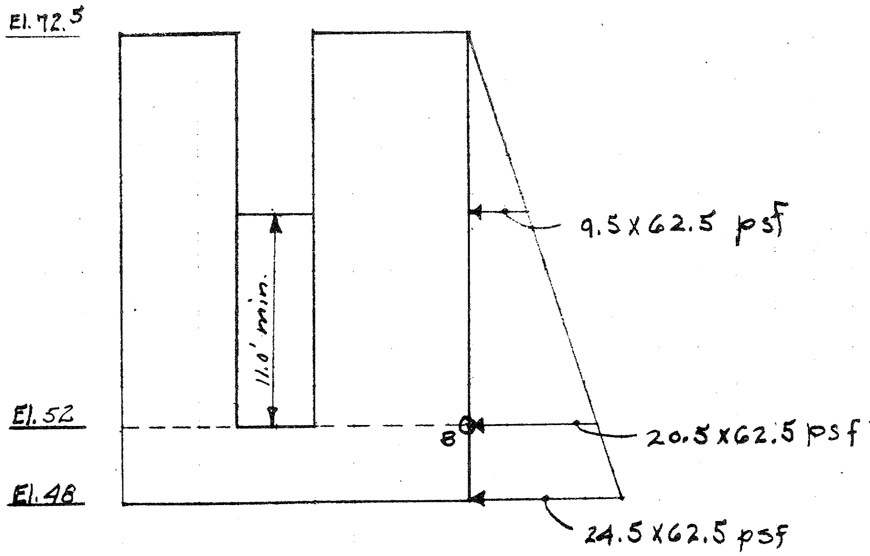
$\dfrac{\Sigma M_A}{\Sigma V} = \dfrac{15{,}831{,}500}{1{,}358{,}700} = 11.66'$ inside mid 1/3 by 0.33' = 4"

O.K.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT Cherry Field Dam
COMPUTATION East Abutment - Tie Design
COMPUTED BY GFH CHECKED BY ______ DATE 24 Feb. '60



Without Ties

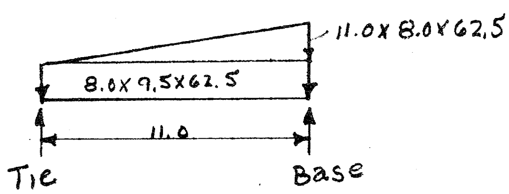
$\Sigma M @ B$ for 8.0' section @ 1.0' width $= (62.5 \times 20.5 \times 10.25 \times 1.0 \times 6.83) = 89{,}600$ lb-ft

$\Sigma V = 110 \times 8.0 \times 20.5 \times 1.0 = 18{,}025^{\#}$

$f = \dfrac{18{,}025}{8 \times 1} \pm \dfrac{89{,}600 \times 6}{1 \times 8.0^2} = 2{,}253 \pm 8{,}400 = 10{,}653$ psf Comp.
$-6{,}147$ " Ten.

With Ties

Assume Ties @ 8.0' o.c. horizontally + 1'-4" o.c. vertically:



$R_{TIE} = \left(8.0 \times 9.5 \times 62.5 \times \dfrac{11.0}{2}\right) + \left(8.0 \times 11.0 \times \dfrac{62.5}{2} \times \dfrac{11.0}{3}\right) = 26{,}100 + 10{,}100 = 36{,}200^{\#}$

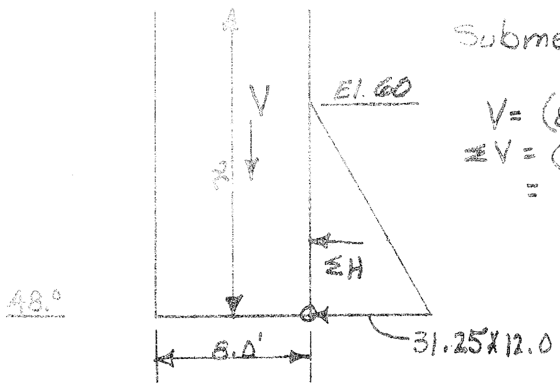
Cross-section area $= 56.3\ in^2$ Comp. Stress $= \dfrac{36{,}200}{56.3} = 643$ psi
less than 775 psi

Use ties above Fishway spaced at 8.0' o.c. horizontally + 1'-4" o.c. vertically.

SUBJECT Cherry Field Dam
COMPUTATION East Abutment - Wing Walls - Stability
COMPUTED BY GEK CHECKED BY DATE 24 Feb 60

South Wing Wall

1.0' Section - taken at 8.0' south of abutment



Submerged condition w/ submerged wts. of soil

$V = (8.0)(1.0)x = 8x$ c.f.

$\Sigma V = (0.85)(8x)(70) - (0.15)(8x)(12.5)$

$= 476x - 15x = 461x$ #

$9000 + 1844x = (461x)(5.33) = 2460x \quad x = \frac{9000}{616} = 14.6'$

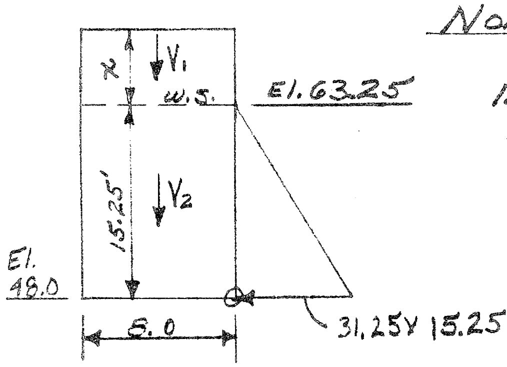
Saturated condition w/ sat. wt. of soil

$V = 111 \times 8.0x = 888x \quad \Sigma M = 18000 + (888x)(4.0)$

$= 18000 + 3552x$

$18000 + 3552x = (888x)(5.33) = 4730x \quad x = \frac{18000}{1178} = 15.3'$

North Wing Wall



1.0' section taken at 4.0' from abutment
structure submerged below el. 63.25
Try 8.0' base width

$V_1 = 8x$ c.F $\quad \Sigma V_1 = 888x$ #

$V_2 = 8.0 \times 15.25 = 122$ C.F.

$\Sigma V_2 = (0.85 \times 122 \times 70) - (0.15 \times 122 \times 12.5)$

$= 7260 - 230 = 7030$ #

$\Sigma V = 7030 + 888x$

$\Sigma M = \left(31.25 \times \frac{15.25^3}{6}\right) + (7031 + 888x)(4)$

$= 18{,}480 + 28{,}124 + 3552x = 46{,}600 + 3552x$

$46{,}600 + 3552x = 5.33(7031 + 888x) = 37{,}400 + 4730x$

$9{,}200 = 1180x \quad x = 7.8'$

Use top el. @ 72.5

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION

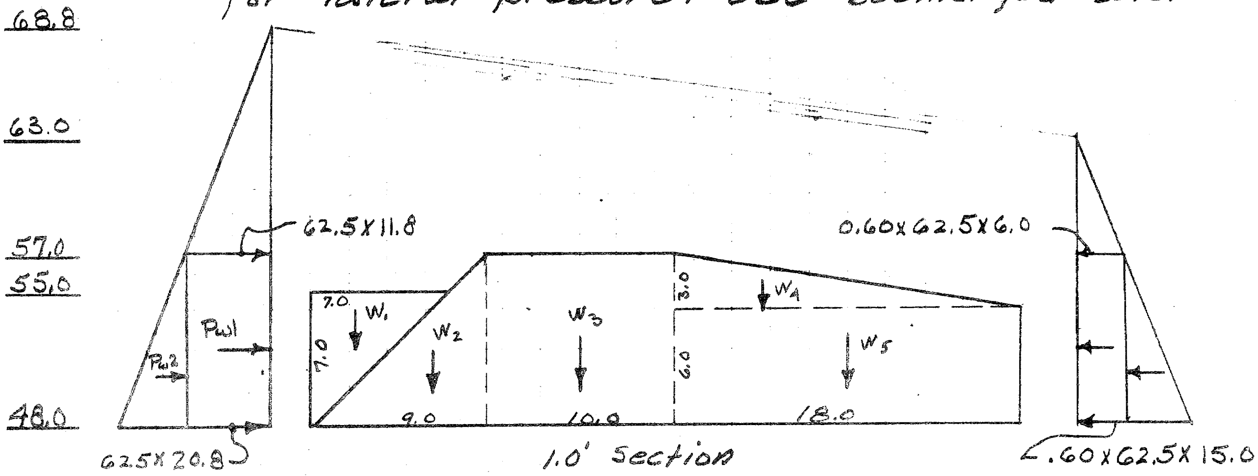
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT: Cherry Field Dam

COMPUTATION: Spillway Weir - Stability

COMPUTED BY: GFH CHECKED BY: DATE: 25 Feb. 1960

Case I : Full flood-water flow w/ headwater @ el. 68.8 + tailwater @ el. 63.0. Use 60% tailwater head for lateral pressure. Use submerged wts.



1.0' Section

$$\Sigma V = \overset{24.5}{(7.0 \times 3.5)} + \overset{40.5}{(9 \times 4.5)} + \overset{90}{(10 \times 9)} + \overset{27}{(3 \times 9)} + \overset{108}{(6 \times 18)} = 290 \text{ cu. ft.}$$

$$\Sigma H = 62.5\left[\overset{106.2}{(11.8 \times 9.0)} + \overset{40.5}{(9.0 \times 4.5)}\right] - 37.5\left[\overset{54.0}{(6.0 \times 9.0)} + \overset{40.5}{(9.0 \times 4.5)}\right]$$

$$= (62.5 \times 146.7) - (37.5 \times 94.5) = 9{,}160 - 3{,}540 = 5{,}620\#$$

$$\Sigma V = (0.85 \times 290 \times 70) - (0.15 \times 290 \times 12.5) = 17{,}260 - 540 = 16{,}720\#$$

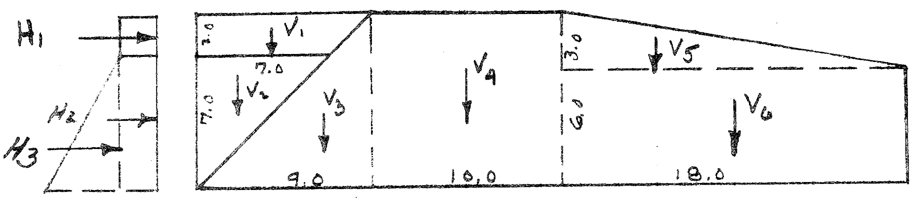
$$\frac{\Sigma H}{\Sigma V} = \frac{5620}{16{,}720} = 0.336 < 0.577 \quad \text{O.K.}$$

SUBJECT Cherry Field Dam

COMPUTATION Spillway Weir - Stability

COMPUTED BY GFH CHECKED BY DATE 25 Feb. '60

Case II: Pool @ top of spillway w/ice 2.0' thick; no tailwater. Use 110 pcf density for soil in & out of crib. Use 55 pcf " " ice. Use 5,000 psf lat. ice pressure @ 2.0' thick



$\Sigma V = (55 \times 2.0 \times 8.0) + (110 \times 290) = 880 + 31,900 = 32,780^{\#}$

$\Sigma H = (5,000 \times 2.0) + (62.5 \times 2.0 \times 7.0) + (62.5 \times 7.0 \times 3.5)$

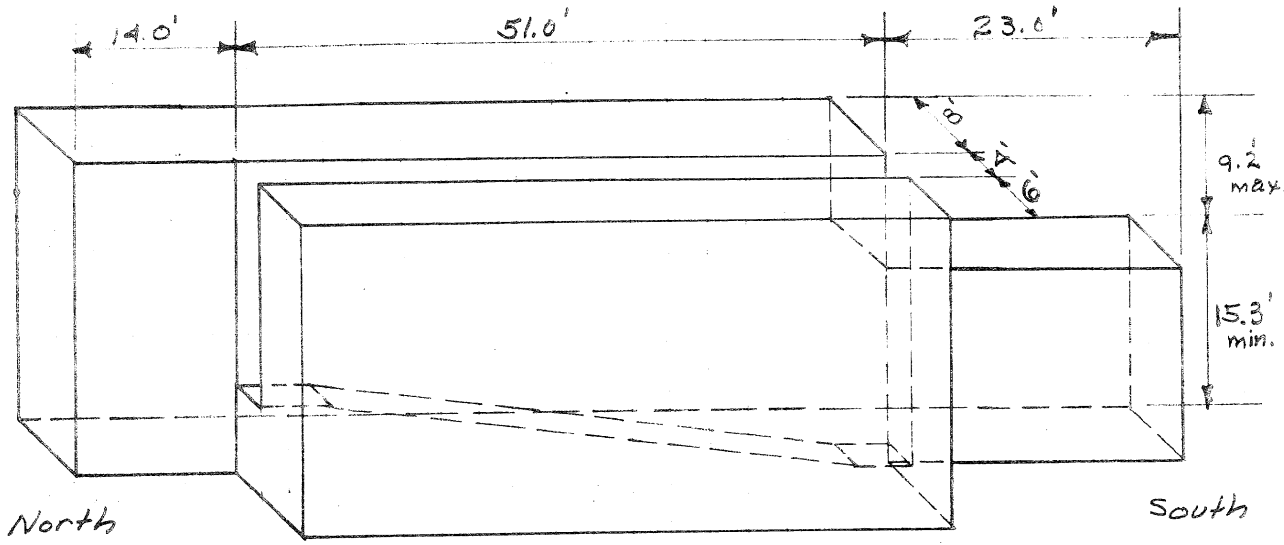
$= 10,000 + 875 + 1,530 = 12,405^{\#}$

$\frac{\Sigma H}{\Sigma V} = \frac{12,405}{32,780} = 0.378 < 0.577$ O.K.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT [illegible] Dam
COMPUTATION East Abutment
COMPUTED BY JFH CHECKED BY ______ DATE 26 Feb. '60



Looking East @ East Abutment

GERRY WADE
SUPT. OF HATCHERIES
ELMER H. INGRAHAM
CHIEF WARDEN
DR. W. HARRY EVERHART
CHIEF, FISHERY RESEARCH AND MANAGEMENT
LYNDON H. BOND
COORDINATOR, FISHERY RESEARCH
C. KEITH MILLER
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LAURENCE F. DECKER
CHIEF ENGINEER
WINIFRED E. CLARK
SECRETARY TO COMMISSIONER

DEPARTMENT OF
Inland Fisheries and Game
ROLAND H. COBB, COMMISSIONER
GEORGE W. BUCKNAM, DEPUTY COMMISSIONER
AUGUSTA

February 15, 1960

Division Engineer
U. S. Army Engineer Division, N. E.
Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

SUBJECT: Narraguagus River Flood Control Dam, Cherryfield, Maine.

Dear Sir:

On February 12, 1960 a meeting of the Atlantic Salmon Commission was held in Augusta, Maine, and among other topics discussed was the proposed flood control dam on the Narraguagus River in Cherryfield. The main concern of course is that the best possible passage be provided for migratory fish.

The undersigned has been in frequent consultation with Mr. Malstrom of your office, and it is our understanding that the dam and fishway are still in the process of design, with cost studies being made of several possible types of structures. At this time I would like to review the points we feel should be considered for the proper operation of the fishway.

The Denil type fishway shown on your preliminary drawings is approved. The baffle portion of the passage would have a length of 37'-4", with each baffle being 3'-6" wide and 7'-0" long. The floor elevation of the passage would be at elevation 49.0 at the fishway entrance and 55.0 at the exit.

The portion of the fishway passage between the last or upper baffle and the gate should be free of cross timbers to permit the installation and operation of a fish trap. In addition vertical guides of similar construction to those provided for the baffles should be provided, one set being about one foot upstream from the last baffle and the second set being about one foot downstream from the fishway gate. These will serve to hold fish trapping screens and plank.

EXHIBIT NO. 1

Division Engineer, U. S. Army Engineer Div. N.E.   February 15, 1960

The fishway gate and trash rack openings should extend to the same height as the top of the upper baffle, or to approximately elevation 61.0. This will prevent these openings acting as submerged orifices during high water periods.

As much of the remains of the old dam located downstream from the new structure should remain in place as possible, with excavation below the new dam held to a minimum in order not to change the flow characteristics of the river. We are especially concerned that a channel be not formed on the right side, opposite the fishway, in a manner that would lead fish up the wrong side.

Stop logs in the sluiceway next to the fishway should be kept somewhat lower than the crest of the dam to provide water attraction and to prevent formation of a back eddy at the fishway entrance.

A link wire type fence with gate should be provided along the shore side of the fishway to prevent unauthorized persons from molesting the fish or fishway.

Most of the above points have been previously discussed with your office, but it is felt that they should be summarized at this time to prevent any misunderstanding.

We shall, of course, be pleased to examine or discuss any additional preliminary plans or proposals, and will wish to have copies of final drawings for our records and approval.

Very truly yours,

Laurence F. Decker

Laurence F. Decker,
Chief Engineer

LFD:lfy

Cc. Roland H. Cobb
Horace Bond
Ronald W. Green
Harry Everhart
Arthur Hutchins

STATE OF MAINE
OFFICE OF THE GOVERNOR
AUGUSTA

JOHN H. REED
GOVERNOR

February 16, 1960

Brigadier General Alden K. Sibley
Chief, New England Division
U. S. Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear General Sibley:

I am very interested in the proposal to provide the Town of Cherryfield, Maine, with protection from floods caused by ice jams on the Narraguagus River. Such floods have caused serious damage in Cherryfield over the years; the effects were particularly severe in 1959.

It is my understanding that the proposed dam would provide adequate facilities for fish passage, thus assuring the perpetuation of the Atlantic Salmon potential on this river.

I shall be pleased to give careful study to the report of your office on this proposed project when the report has been completed.

Sincerely,

John H. Reed

John H. Reed
Governor

JHR:jd

EXHIBIT NO. 2

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.

NEDGW

25 Feb 1960

Honorable John H. Reed
Governor of the State of Maine
State House
Augusta, Maine

Dear Governor Reed:

Thank you very much for your letter of February 16, 1960 in which you expressed your interest and support for the proposed ice-jam flood control dam on the Narraguagus River at Cherryfield, Maine.

In their letter of February 15, 1960 the Maine Department of Inland Fisheries and Game approved the Denil type fishway to be incorporated in the dam structure for passage of migratory fish, especially Atlantic Salmon.

The Selectmen of the Town of Cherryfield have informed me that they are inserting an article in the Town Warrant, to be acted on March 14, 1960, for approval of the voters for the usual requirements of local participation and cooperation asked of the sponsoring organization for a flood control project under Public Law 685.

As soon as the Detailed Project Report has been completed I will submit it to you for study and comment.

Sincerely yours,

KARL F. EKLUND
Colonel, Corps of Engineers
Acting Division Engineer

EXHIBIT NO. 3

Cherryfield, Maine
March 23, 1960

Alden K. Sibley, Brigadier General
U. S. Army Division Engineer
Waltham, Massachusetts

Dear General Sibley:

With reference to the study of the Narraguagus River at Cherryfield, Maine, relative to flood control measures providing for a dam to retain ice in the Stillwater area, so called, Article 39 in the Town Warrant was acted upon at the Annual Town Meeting held in Cherryfield on March 14, 1960. Article 39 read as follows:

"To see if the Town will vote to agree to certain conditions of cooperation, in accordance with Public Law 685, adopted July 11, 1956, in the event that protective flood control measures are undertaken on the Narraguagus River by the Federal government:

a. Furnish all necessary lands and rights of way.
b. Hold and save the United States free from all claims of damage growing out of or incidental to the construction work.
c. Maintain and operate the project after completion in accordance with regulations prescribed by Secretary of the Army.
d. Assume all project costs in excess of Federal cost limitation of $400,000, found necessary to provide a complete project."

It was voted by the Town to accept all the conditions of the article and the citizens, by vote, appointed a committee of seven men to follow through on the project and assist the Department of the Army in any way possible and to work for the earliest accomplishment of the work, if and when the project is approved. The undersigned was designated as Chairman of the Committee. This information was given to Mr. Malmstrom of your Engineering Division on Tuesday, March 15, 1960.

After a study by the Committee, it has been determined that a fair estimate of the lands and rights of way that would be furnished by the Town would cost $3,500.00. An acre of land at the east abutment of the dam, to be used for a gravel borrow area, can be purchased for $25.00, if needed, which is included in the above figure. It is also estimated that under the present system of valuation in the Town the annual tax loss to the Town by the necessary land takings would amount in the vicinity of $200.00

EXHIBIT NO. 4

In representing the citizens of the Town of Cherryfield, the Committee is anxious to cooperate with your office in every way possible. If there is anything that can be done here, or any information you might require, please let us know. The ice situation is not quite as serious now and, with good luck and no extremely heavy rain, we have a good chance of getting by this year without another flooding. The threat is here each year, so it is the earnest hope that this time a favorable project can be worked out for an early accomplishment.

Very sincerely yours,

Clarence A. Tucker

Clarence A. Tucker

STATE OF MAINE
OFFICE OF THE GOVERNOR
AUGUSTA

JOHN H. REED
GOVERNOR

October 7, 1960

Colonel Karl F. Eklund
Acting Division Engineer
Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Colonel Eklund:

I have reviewed with interest your letter relative to the proposed Local Protection Project on the Narraguagus River, Cherryfield, Maine.

I feel that this project would be very beneficial to the Town of Cherryfield in solving the ice dam flood problems, and would appreciate all consideration that may be given to favorable recommendation that this project be accepted.

It is the feeling of our state officials, as well as the Town of Cherryfield, that this would be a feasible project.

Sincerely yours,

John H. Reed

John H. Reed
Governor

JHR:md

EXHIBIT NO.4A

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Orono, Maine

June 12, 1959

General Alden K. Sibley
Division Engineer
U. S. Army
424 Trapelo Road
Waltham 54, Mass.

Dear General Sibley:

In your letter of May 6 concerning flood problems on the Narraguagus River at Cherryfield, Maine, you asked that I keep you informed of our plans in regard to this matter.

Mr. Eley and Mr. Karban from our Upper Darby office, spent several days in the Watershed with me and our State Engineer. We are agreed that the problem is not related to the condition of the land or the use of the land in the watershed for agriculture or forestry.

Since you indicated that you had requested funds for the preparation of a detailed plan for a project, and when Mr. Eley and Karban called at your office on May 21st they were informed that you had received the funds and were preparing a plan, we are taking no further action.

I am writing to several of the local people whom we contacted informing them that I think this is a project which should be handled by the Corps rather than the Department of Agriculture. If we in the Soil Conservation Service can be of any help to your organization, we will gladly do what we can.

I have been keenly interested in the Salmon restoration work on this river and will be very much interested in any project the Corps may develop.

Cordially yours,

William B. Oliver

William B. Oliver
State Conservationist

EXHIBIT NO. 5

COMMISSIONERS
DAVID H. STEVENS
CHAIRMAN
PERRY S. FURBUSH
R. LEON WILLIAMS

VAUGHAN M. DAGGETT
CHIEF ENGINEER

State Highway Commission

State of Maine

Augusta

August 26, 1959.

Division Engineer
U. S. Army Engineer Division
New England Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts.

Attention: John Wm. Leslie, Chief, Engineering Division.

Dear Sir:

This is in reply to your letter of August 18 1959, your file NEDGW, relative to a proposed dam at Cherryfield, Maine.

The State Highway Commission can see no need, immediate or future, for a roadway on the dam if it is constructed in the location as described.

The two existing bridges across the Narraguagus River at Cherryfield adequately serve highway requirements.

Yours very truly,

Chief Engineer.

VMD:gl

EXHIBIT NO.6

CONNECTICUT
MAINE
MASSACHUSETTS
NEW HAMPSHIRE
NEW JERSEY
NEW YORK
RHODE ISLAND
VERMONT

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
REGION ONE

Room 202, Post Office Bldg.
Augusta, Maine

September 18, 1959

Division Engineer
U. S. Army Engineer Division
New England Corps of Engineers
424 Trapelo Road
Waltham 54, Massachusetts

Dear Sir:

This is in reply to your letter of August 18, 1959, your file NEDGW, relative to a proposed dam at Cherryfield, Maine.

We concur with the State Highway Commission's findings that there is no need immediately or future for a roadway on the dam if it is constructed in the location as described.

The two existing bridges across the Narraguagus River at Cherryfield adequately serve highway requirements.

Very truly yours,

R D Hunter

R. D. Hunter
Division Engineer

EXHIBIT NO.7

CHERRYFIELD ROD & GUN CLUB
Cherryfield, Maine

November 4, 1959

The Division Engineer
U. S. Army Engineer Division
New England Corps of Engineers
424 Trapelo Road
Waltham 54, Mass.

Dear Sir: Re: File No. NEDGW

On October 22, 1959, a meeting of the Cherryfield Rod & Gun Club, a conservation organization of over fifty members, was held for the purpose of discussing the proposed construction of a dam at Stillwater Pool. It was unanimously voted not to favor this project. As secretary of this club I was fully authorized to call your attention to the following facts:

1. Ice Control. In regard to ice control on the Narraguagus River, we feel that a dam at the Stillwater site would have little effect in curbing ice jams in the Town of Cherryfield. We believe that a large portion of the ice which usually jams in the center of town accumulates from the 1½ miles of river between the Route #1 bridge and the Stillwater site. This portion of river is fast moving and normally does not freeze to any considerable depth. When below normal temperature and continued cold weather occur, it will freeze deep and solid. This being a rough and fast moving section of river, the ice will quickly break up during a freshet and cause it to move down river and pile up on the dead water ice in the center of town, thus causing a dam of ice and backing up of water until it floods into the main street. The ice above the Stillwater site will usually hold in this dead water section and stay in that location. We doubt if a low crib dam at Stillwater could hold enough water to stop a freshet of any serious proportion.

2. Obstruction. A dam at the Stillwater Pool would not only destroy the most popular and productive Atlantic Salmon Pool in the United States today, but would ruin two or three miles of productive salmon pools above the dam site. Every possible pool is needed now and even more in the future to accommodate the increasing number of fishermen coming to Cherryfield each year to spend their vacations. Any dam would cause an obstruction and bottleneck to the salmon migrating up river to spawn. Obstructions such as this have played a large role in the decrease of Atlantic Salmon, and in some rivers have completely depleted the run. Although a fishway would be installed, who can predict that such fishway will be satisfactory? In most cases, a long period of

EXHIBIT NO.8

time is required to make a fishway at all workable, and this would decrease the salmon run over such period of time.

3. Water Control. If there is any thought that after a dam has been constructed it will also be used for water control to try and lure Atlantic Salmon in to the river, the use of this Beaver Pond type water could serve to turn the fish away instead of bringing them in from the cold sea water. It is our opinion that the Army Engineers should obtain their advice on water control from the State Salmon Biologists and not from local organizations and uninformed individuals. The creation of any impoundment of water would have a very bad effect on fish such as trout and salmon, but the existing population of warm water fish such as grass pickerel, bass, and chubs would increase rapidly.

4. Alternative Plans. The most serious damage from flood water in the Town of Cherryfield occured in 1942 and again in 1959. On the latter occasion, no attempt was made to prevent the rise of water by emergency measures, such as sandbagging or the use of explosives. When dynamite was finally used it was found that the tidewater ice extended so deep to the mud bottom, that in most cases it did not even allow the placing of a one gallon jug containing the dynamite charge. If it is the opinion of the authorities that a large expenditure of Federal funds is justified after proper consideration of the assessed valuation of the properties in danger, it is the sincere desire of the members of this organization that careful study be given to such preventive measures as might be carried out without such serious threat to the Atlantic Salmon as a dam obstruction in the river. We propose that the authorities investigate the beneficial effect of dredging or deepening the tidal area from Route #1 bridge to Milbridge; (2) raise the level of the present bridge on Route #1 which has not the proper clearance above high water level, and acts as an obstruction to the free passage of ice; (3) erect a system of dikes or embankments in the right location to prevent the flooding of water in the Main street; (4) erect a system of ice-breaking piers in the lower reaches of the river.

Sincerely,

Fred Curtis

Fred Curtis, Secretary

OFFICE OF SELECTMEN
ASSESSORS AND OVERSEERS OF POOR

TOWN OF CHERRYFIELD, MAINE

Dec. 12, 1959

The Division Engineer,
U. S. Army Engineer Division,
Corps of Engineers,
424 Trapelo Road,
Waltham 54, Mass.

Dear Sir: Re: File No. NEDGW

Thank you for your letter of November 16th, 1959 with enclosed copies of letters from Mr. Fred Curtis and the Cherryfield Rod and Gun Club regarding the Narraguagus River Ice Control Project, which letters were submitted after the Public Hearing held in Cherryfield on November 4th, 1959.

These communications contain many statements with which we cannot agree and which could easily be induced by the more or less selfish interests of the individuals responsible. For example, the Cherryfield Rod and Gun Club would seem to be mainly a paper organization, which actually consists of a few people who were originally members of The Narraguagus Salmon Association and were not satisfied to go along with the more liberal views of that group. The membership figure of fifty people is a bit questionable, we would say.

Mr. Curtis is very naturally interested in the salmon fishing as heoperates the home known as the Salmon Lodge, located on high ground overlooking the river but out of the flood area, for paying guests during the fishing season. Mr. Joseph Moloney, who has cabins for hunting and fishing guests on the outskirts of the town, has also taken the same views as Mr. Curtis in opposition to the dam because of what disastrous effects it might have on the salmon fishery. I believe he is also an officer of the Rod and Gun Club. Both are newcomers to town, so to speak, as neither one lived here when there were dams on the river, and the only flooding they have witnessed here is probably the one of last April.

It is true that there is often quite a bit of ice formation between the Stillwater dam site and the lower end of the town, but in almost every instance the real damage has occurred when the ice above Stillwater let go and came downstream. As for sandbagging the river banks, most people would agree that the huge ice cakes would not be long in making that ineffective.

EXHIBIT NO.9

OFFICE OF SELECTMEN
ASSESSORS AND OVERSEERS OF POOR

TOWN OF CHERRYFIELD, MAINE

U. S. Army Engineer Div.

Both these gentlemen are strong supporters of the opposition manifested by the Fish and Wildlife Department. The town officials, least of all, would wish to sponsor any project whatsoever which would be detrimental to the general economy of the town or detract from property valuation. We are indeed glad to welcome all those who derive any measure of pleasure or relaxation from resources which we have to offer, but we certainly know from actual records that, to quote, "the overall valuation of property in Cherryfield depends more on Atlantic Salmon than any other industry" is a misstatement. We would say that probably about 80% of the fishermen are people within the radius of a day's trip and bring very little in the way of financial income to the town. The proprietor of the Cherryfield Inn has publicly stated that they do derive some income from the fishermen, but of no outstanding figure.

A reference was made to spoiling the best salmon pool on the river by construction of a dam at Stillwater. It would seem that in the event of such a misfortune other pools could be made, as has been done previously. Money has been appropriated by the town to go along with the Narraguagus Salmon Association in making this possible. We see no reason why a pool could not be made within the fishing limits in the swift water from the fish way. The old time fish ladders used when all the dams were in the river were very effective in permitting the salmon to migrate upstream. Any number of local residents can testify as to that.

The figures used by the opposition to convey an idea of such enormous damage to result from the dam construction are far from convincing to the majority of the people concerned and we certainly hope they will not be allowed to offset the real benefits we hope to derive from the project.

Yours very truly,

Louis S. Moore

Chairman
Board of Selectmen

WALTER TUCKER
PRESIDENT

THOMAS HEALD
VICE PRESIDENT

PHIL HARRIMAN
SECRETARY

ALVAH TRACY
TREASURER

Narraguagus Salmon Association

CHERRYFIELD, MAINE

36 Pitt St.
Portland, Me.
December 12, 1959

Area Engineer
U.S. Army Engineer Division
New England Corps of Engineers
Portland Area
P.O. Box 977
Portland, Maine

Dear Sir:

This is in reply to your letter of December 11, 1959, requesting comments on letters dated November 4th and 7th from the Cherryfield Rod and Gun Club and Mr. Fred Curtis, regarding their opposition to the proposed ice-control dam in Cherryfield.

First I would like to comment on the nature of the Cherryfield Rod and Gun Club. In my opinion, it is not a bonafide sportsmen's club but, instead, is a "paper" organization which was hastily organized by a small group of dollar-conscious men following the Salmon Commission's black-salmon hearing in Cherryfield last March. The group was organized at a secret meeting and membership was not open to the public in general. Its primary purposes are to promote black salmon fishing on the Narraguagus, to serve as a mouthpiece for the Salmon Commission and to oppose the Narraguagus Salmon Association in <u>all</u> matters. It is not a conservation organization in any way. In the town of Cherryfield there is no evidence that such a group exists other than the occasional appearance of a letter written by Mr. Curtis in the Bangor News praising the Salmon Commission or criticizing the Advisory Council or the Narraguagus Salmon Association. Certainly the Cherryfield Rod and Gun Club is not representative of the businessmen or residents of the town of Cherryfield and, in my opinion, its arguments in opposition to the proposed ice-control dam should receive little or no consideration from the Corps of Engineers. The fact that this group declined to submit its letter at the hearing in Cherryfield on November 4th in order that it might be read into the record speaks for itself. I doubt that the 50 (?) members of the group voted on this matter or are aware of the contents of the letter.

With reference to the Cherryfield Rod and Gun Club's letter of November 4th, I would comment on Mr. Curtis' four paragraphs as follows:

1. <u>Ice Control</u>

(a) His statement that the ice which jams in the center of the town of Cherryfield comes from that section of the river below the Stillwater Pool is false. It is common knowledge that the ice

EXHIBIT NO. 10

which caused the 1959 ice jam, as well as previous jams, came from above Stillwater.

(b) Mr. Curtis is apparently unaware of the fact that the main street of Cherryfield has never suffered damage from freshets or floods alone, even in those years when the winters were much more severe than in recent years. He is also unaware of the fact that the proposed dam is an ice-control structure and is not designed to control freshets or floods.

2. Obstruction

(a) Official rod-catch records indicate that Stillwater Pool is not always the most popular or the most productive salmon pool on the Narraguagus. In four of the past twelve years, the rod catch at Little Falls Pool exceeded that at Stillwater, and in two of the past twelve years, the rod catch at Academy Pool exceeded or èqualled the Stillwater total. The average Stillwater rod catch over the past 12 years has been only 20 fish annually. Certainly the loss of 20 fish each year is a small sacrifice when weighed against protection for the town of Cherryfield. And who can say that these 20 fish would not be caught elsewhere on the river due to increased fishing pressure on other existing pools or newly developed pools?

(b) Mr. Curtis' statement that a dam at Stillwater would ruin two or three miles of "productive" salmon pools above the dam site is false. There is only one existing salmon pool in the Stillwater flowage area, known as The Forks Pool, and the average rod catch as shown by official rod-catch records is <u>one</u> fish per year.

(c) The proposed dam, in my opinion, would not cause an obstruction and bottleneck as Mr. Curtis states. I have discussed this matter with recognized Canadian salmon experts and they agree that a small dam of this type equipped with a properly designed Denil Type fishway would offer little or no obstruction to migrating salmon, particularly in view of the fact that a gate is to be provided in the dam, which would permit its being operated "wide open" during low water periods if necessary. One of Canada's experts went so far as to say that dams can be beneficial to fish, this being with reference to their use for water-control purposes. It is a fact that many of Canada's small salmon rivers have dams which have no adverse effect on the salmon runs. There is certainly no known case where a dam with a properly designed fishway depleted a salmon run either in Canada or in the United States.

3. Water Control

(a) Mr. Curtis' statement in this paragraph is nothing more than an indirect attack on the Narraguagus Salmon Association's original request that the proposed dam be a combined flood and water-control dam. He is unaware of the fact that we, realizing that the amount of water stored behind the proposed ice-control dam would be insufficient for the creation of artificial freshets, are no longer proposing a water-control dam. He is also unaware of the fact that the Canadians have experimented with water control dams for the creation of artificial freshets and have found them "biologically sound" for controlling salmon migrations in a river (Fisheries Research Board of Canada Bulletin No. 99).

4. **Alternative Plans**

(a) It appears to me that the logical way to prevent further damage to the town of Cherryfield from ice-jams and resultant flooding is to eliminate the cause of the ice-jams rather than to try to control the movement of the ice after it has started downstream. The proposed Stillwater Dam would undoubtedly eliminate the cause of the ice jams by providing a large solid sheet of ice behind the dam which would prevent ice from further up river from passing downstream.

(b) As an engineer, I believe that the proposals of dredging, sandbagging, dikes, moving buildings, raising bridges etc. are "childish"; no doubt they are suggested more as a delaying tactic rather than for serious consideration.

The statements that I have made in this letter should also serve to refute certain misleading information which was presented to the Corps of Engineers by the Maine Sea-Run Salmon Commission and the U.S. Fish and Wildlife Service.

After reading the U.S. Fish and Wildlife Service's letter of August 19th to the Corps and after discussions with their biologist, Mr. Franz, it appears to me that their stand was based on conversations with Salmon Commission biologists rather than on the results of a thorough investigation; in fact, they stated on page 6 of their letter that their analysis was "preliminary" and "inadequate".

The statements presented to the Corps by the Salmon Commission indicate that they are worried more about the loss of the Stillwater Pool portion of the Narraguagus River rod catch (20 fish per year), with its possible adverse effect on their publicity releases and reputations, than they are concerned about protection for the town of Cherryfield. They have only to consult with the Canadian experts to learn that the proposed ice-control dam will have little or no effect on salmon runs in the Narraguagus River.

Very truly yours,

John P. Harriman

John P. Harriman, Secretary

FEDERAL POWER COMMISSION
REGIONAL OFFICE
139 CENTRE STREET, NEW YORK 13, N. Y.

March 7, 1960

The Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

Subject: Proposed Cherryfield Dam, Narraguagus River, Maine

Dear Sir:

Reference is made to your letter dated February 15, 1960 concerning the proposed Cherryfield flood control project, Narraguagus River, Maine, on which a Detailed Project Report is currently being prepared in your office. Presented herein are our conclusions with respect to power development at the Cherryfield project and at other potential sites in the Narraguagus River basin which appear to merit further consideration for multiple-purpose use.

As stated in your letter, the proposed Cherryfield dam and reservoir, authorized by Public Law 685, 84th Congress, for control of ice-jam flooding on the Narraguagus River would be located about one mile above tidewater at Cherryfield. It would involve the restoration of a low timber crib dam at the Stillwater site which was effective in preventing ice jams and flood damage prior to 1942. The reconstructed dam would consist of a rock-fill timber crib spillway with crest at elevation 57.0. Earth abutments at elevation 72.5 would provide freeboard for passing high flows and for holding ice flows in the reservoir. The reservoir area at spillway crest is about 500 acres and 2,300 acres at elevation 70. Drainage area at the site amounts to 232 square miles.

Our studies indicate that development of power at the proposed Cherryfield dam would not be practicable because of the low head available (5') and low stream flow (min. monthly - 40 cfs). However, it appears that the proposed project could provide valuable pondage for the operation of a potential power development immediately downstream of the site. This would require the future installation of flashboards on the Cherryfield dam to provide about 6,000 acre-feet of pondage between elevation 57.0 and 63.0. Additional conservation

EXHIBIT NO. 11

storage necessary for power and other purposes could be provided most economically by construction of a headwater reservoir on Barrel Brook. At full pool elevation 385, the reservoir capacity would amount to about 30,000 acre-feet which would be adequate to maintain a regulated flow of about 210 cfs at Cherryfield.

The suggested power development below Cherryfield would require reconstruction of an old dam about 1,000 feet below the railroad bridge. A 10'-diameter pipeline about 800 feet in length would convey water to a 2,000-kilowatt power plant located below the highway bridge (T.w. elev. 10±). Gross head would amount to about 40 feet and average annual generation about 9,000,000 kilowatt-hours. Location of the potential projects are shown on the attached sketch.

Based on the results of our studies, it is concluded that the power potential of the proposed Cherryfield dam is small, and not practicable of economic development. Therefore, the installation of penstocks or similar facilities for the possible future development of power at the site would not be required.

Sincerely yours,

D J Wait

D. J. Wait
Regional Engineer

Inclosure 100979
Sketch

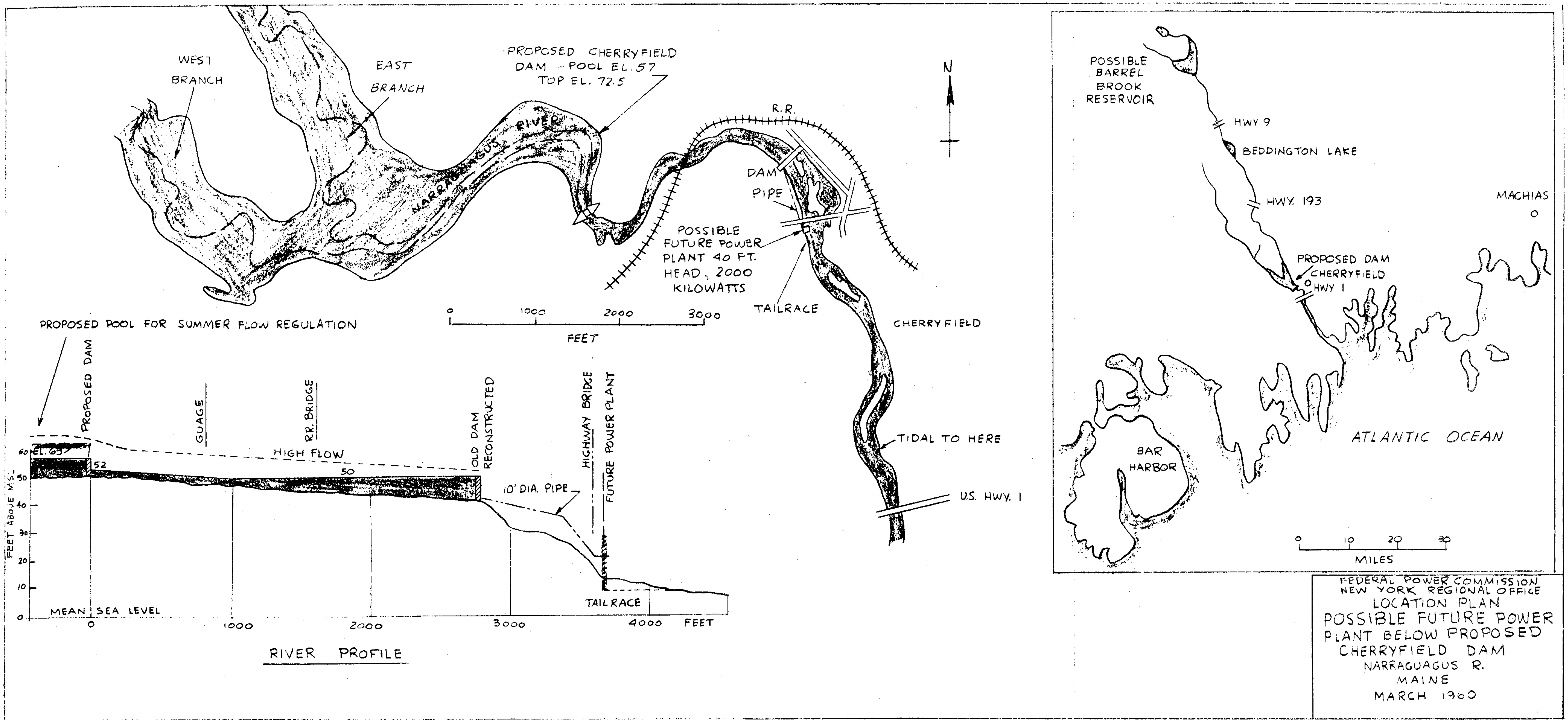

EXHIBIT NO. 11 A

ADDRESS ONLY THE
REGIONAL DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
59 TEMPLE PLACE
BOSTON, MASSACHUSETTS

NORTHEAST REGION
(REGION 5)
MAINE
NEW HAMPSHIRE
NEW YORK
VERMONT
PENNSYLVANIA
MASSACHUSETTS
NEW JERSEY
RHODE ISLAND
DELAWARE
CONNECTICUT
WEST VIRGINIA

April 4, 1960

Division Engineer
New England Division
U. S. Corps of Engineers
424 Trapelo Road
Waltham, Mass.

Dear Sir:

Attached is a draft of the conclusions and recommendations of our fish and wildlife report on the Cherryfield Dam and Reservoir Project, Maine. A complete draft of the report will be forwarded to you shortly for your review and comments. At this time, it would be helpful if your staff could complete the cost estimate blanks in the recommendations and return them to us as soon as possible. Inclusion of these cost estimates will strengthen our recommendations and add to the usefulness of the report.

Thank you for your cooperation in this matter.

Sincerely yours,

M A Marston

M. A. Marston, Chief
Division of Technical Services

Attachment

EXHIBIT NO. 12

DRAFT

Conclusions and Recommendations - Fish and Wildlife Preliminary Report, Cherryfield Dam and Reservoir Project, Maine

In view of the foregoing it is concluded that the Cherryfield Dam will not cause major adverse effects to the Atlantic salmon fishery resource if the recommendations of this report are accepted in their entirety. However unless these recommendations are accepted in their entirety this Bureau will have no alternative but to oppose the project.

RECOMMENDATIONS

I recommend:

1. That a Denil-type fishway approved by the Maine Atlantic Sea Run Salmon Commission and costing an estimated \$ 7300.00 be incorporated into the project design.
2. That channeling of the streambed along the left bank of the river for a distance of approximately 150 feet downstream from the fishway be included as a project feature at an estimated cost of \$ 200.00 with exact location, length, width and depth of the channel and deposition of spoil being determined at the site by representatives of the Maine Atlantic Sea Run Salmon Commission in cooperation with the Corps of Engineers.
3. That the responsibility of the Township of Cherryfield for maintenance of the project subsequent to construction be defined to include maintenance responsibility for the fishway and the channelled streambed downstream from the fishway at an estimated annual cost of \$ 300.00 with determination of annual maintenance needs and supervision of maintenance work primarily by the Atlantic Sea Run Salmon Commission in cooperation with the Corps of Engineers and the Town of Cherryfield.
4. That additional detailed studies of fish and wildlife resources affected by the project be conducted as necessary during further planning and construction phases of the project to form the basis for such reasonable modifications for the

conservation and development of fish and wildlife resources as may be desirable to obtain maximum overall project benefits.

5. That additional modifications to achieve maximum project benefits be made in project facilities or operations, subsequent to completion of construction as may be desirable to obtain maximum overall project benefits, on the basis of Follow-up Studies by this Bureau to improve or supplement measures taken for the conservation and development of fish and wildlife resources, notwithstanding Paragraph (g) Section 2 of the Fish and Wildlife Coordination Act.

General Alden K. Sibley
Division Engineer
Waltham, Mass.

April 27, 1960

Dear General Sibley

At a meeting on the Dam Site on April 27, with representatives of the Corps of Engineers and Mr. Richard Cutting of the Fish and Wild Life Service of the State of Maine and the Flood Control Committee of the Town of Cherryfield, the views of the Fish and Wild Life Service were discussed and a channel downstream of the fishway determined at approximately 150 feet long, bottom width of 10 feet to elevation of approximately 47 feet is to be incorporated as a part of the Narraguagus River Project.

This meets with the approval of the Committee representing the Town, and, as part of the project, is accepted for maintenance with the overall project.

Clarence A. Tucker

Clarence A. Tucker, Chairman

Flood Control Committee
Town of Cherryfield

EXHIBIT NO. 13